No Runway?
No Problem >>>

Japan Jumps
Into Space p. 32

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Bad to the Bone
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Rockwell B-1B

AIRSHOW SPECIAL

These Wings Were Made for Walkin'

When the Wrights Took the Show on the Road

Where to See the Shows This Season

WEIRD THINGS FOUND IN OLD AIRPLANES

Hot Heads: NASA's Plan to Fly to the Sun
p. 26

MAY 2008

Love Potion #7?

The New Science of Love with a little wizardry thrown in.

In every great fairy tale, the sorcerers take a little science and throw in a little magic to create the perfect brew that brings two lovers together. Romance is all about chemistry and these seven brilliant stones can add just the right magical fire to raise the temperature of your secret potion. In today's most important design called the "River of Love", this pendant of 2 carats t.w. of graduated Diamond*Aura* stones is the perfect blend of science and sorcery. Our Gemologists have broken the code to create an impeccable stone with even more fire and better clarity than mined diamonds. Of course, the Diamond*Aura* stones are hard enough to cut glass and they are so clear and white that they rival a "D Flawless" diamond in terms of color and clarity. In the laboratory, we have found a way to match the brilliance and stunning reflective qualities of a diamond by using science and thus we avoid the outrageous price.

Perfection from the laboratory. We will not bore you with the details of the ingenious process, but will only say that it involves the use of rare minerals heated to an incredibly high temperature of over 5000˚F. This can only be accomplished inside some very modern and expensive laboratory equipment. After cutting and polishing, scientists finally created a faultless marvel that's optically brighter and clearer with more flashes of color. According to the book *Jewelry and Gems–the Buying Guide* the technique used in Diamond*Aura* offers, *"The best diamond simulation to date, and even some jewelers have mistaken these stones for mined diamonds."*

The 4 Cs. Our Diamond*Aura* jewelry retains every important specification: color, clarity, cut, and carat weight. In purely scientific measurement terms, ***the fire is actually superior to that of a diamond***. Fire is the dispersion of white light into a rainbow of color. Our team of cutters and polishers artistically performs the symmetrically brilliant, 58-facet cut to maximize the light reflection and refraction.

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Clarity	"IF"	"F" Faultless
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2 ct tw necklace	$20,000+	$129

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April/May 2008 | Vol. 23, No. 1

AIR&SPACE
Smithsonian

On the cover: Photographer Ted Carlson was in the air with the 28th Bomb Squadron in December 1996 when a pair of B-1B bombers slalomed through high passes in Colorado's Rocky Mountains. One airman from the 28th, part of the Seventh Bomb Wing at Dyess Air Force Base, Texas, advises, "Never call it a Lancer." (p. 60)

AIRSHOW SPECIAL SECTION: COME AND SEE THE SHOW

Departments

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The *Air & Space* Web site now has a new, searchable archive of every feature published since 2002, plus new videos, interviews, and other fresh content. Sign up on the site for a free e-newsletter.

Features

WHAT IF THE NEXT GLOBAL BATTLEGROUND ISN'T ON THE GROUND?

Viewport

FROM THE DIRECTOR

All in the Family

TO THE MANY GREAT GIFTS the National Air and Space Museum received from Don and Mary Engen, their son Travis and his wife Anne have recently added another: a $15 million donation that will make it possible for us to begin work on a new wing of the Steven F. Udvar-Hazy Center in Virginia. Vice Admiral Donald Engen (ret.) was the Museum director from 1996 to 1999, when he died in a motorized-glider accident. His leadership inspired the Museum staff, won us many friends, and created a momentum that helped carry the Center through to its 2003 opening. The Center's observation tower is named for him.

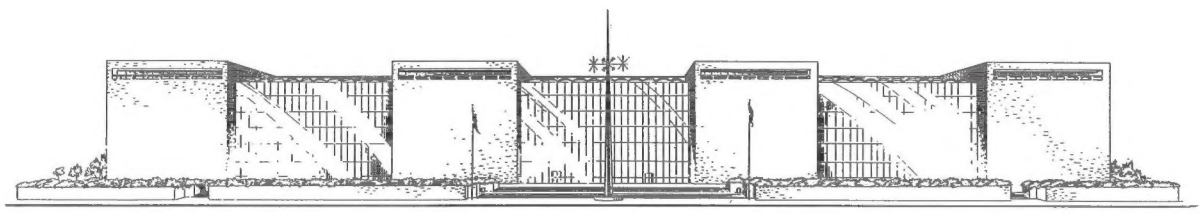
While he was the Museum director, his wife Mary was an energetic advocate, and after his death, she joined our Board of Directors. Mary Engen died in 2006. In making the donation, Travis Engen said the passion his parents felt for aviation and their dedication to the Museum prompted the gift.

The addition that this money will help build will be dedicated to the restoration, preservation, and treatment of artifacts of all sizes, as well as a center for archival research. The largest component will be a restoration facility, named the Mary Baker Engen Hangar, in recognition of Travis and Anne Engen's gift. The hangar will be large enough to accommodate up to six aircraft. Visitors will be able to watch from a mezzanine level as restorers work on the artifacts. When we move the restoration work to this new hangar from its present location at the Paul E. Garber facility in suburban Maryland, we believe the interest the public has shown in restorations completed there over the years will accompany the artifacts to the new home.

A few months before Travis made the decision to help the Museum build the new hangar, he called me to check on the progress of one of those restorations. Among the aircraft waiting their turn to be restored and exhibited at the Udvar-Hazy Center is a Curtiss SB2C Helldiver, similar to the one his dad had flown during the World War II Battle of Leyte Gulf. Now, "Helldiver" is one of the more polite names I've heard used for this dive bomber; some of the early models were known to experience severe buffeting during dives and were famously hard to handle. Nevertheless, the Helldiver, many would argue, was essential to U.S. victory in the Pacific.

Pilots, I've noticed, often feel toward the aircraft they've flown an affection similar to family loyalty: *They* can deride an airplane all they want, but Lord help anybody else who points out its faults, and they often see fine qualities that elude the rest of the world. I think Admiral Engen passed his affection for the Helldiver on to his son, and all of us who love airplanes can understand why Travis is eager to see that airplane restored. The staff at the National Air and Space Museum are grateful that he was inspired to help move that restoration along. And every time I see the restored Helldiver, I know I'll think about family loyalty—and of one exceptional family in particular.

J.R. DAILEY IS THE DIRECTOR OF THE NATIONAL AIR AND SPACE MUSEUM.



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Air & Space/Smithsonian; April/May 2008; Volume 23, Number 1

Air & Space/Smithsonian (ISSN 0886-2257) is published bimonthly by Smithsonian Business Ventures, MRC 513, PO Box 37012, Washington, DC 20013-7012. Periodical postage paid at Washington, DC, and additional mailing offices.

POSTMASTER: Send change of address to *AIR & SPACE/Smithsonian*, PO Box 420113, Palm Coast, FL 32142-0113. Printed in the USA. Canadian publication agreement no. 40039324. Canadian return address: Brokers Worldwide, PO Box 1051, Fort Erie, ON L2A 6C7 Canada.

Subscription Prices: U.S. and possessions: $26 a year payable in U.S. funds. Canada and all other countries: add $6.00 (U.S. funds) per year. Ninety-nine percent of dues is designated for magazine subscription. To purchase an issue (current $4.99, back issue $7), please write *AIR & SPACE/Smithsonian*, 420 Lexington Ave., Suite 2335, New York, NY 10170, or call (212) 916-1379.

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Letters

WRITE TO US

The Quiet One: A Voice From the Past

I was one of the S-58T (Twin-Pac) pilots involved in the Quiet One project ("Air America's Black Helicopter," Feb./Mar. 2008). I was on the October 12 mission, which was aborted due to the malfunctioning of the forward-looking infrared camera, and on the mission scrubbed due to weather. I was also involved in the setting of the relays. My recollection is that we set at least three and that we also accidentally dropped the first one, which caused great consternation at higher levels. As I recall, we looked for it for several days before finally giving up. Anyway, I hope the article has shown readers that Air America was doing something other than smuggling drugs, the vivid (and erroneous) impression given by the lousy Mel Gibson movie *Air America*.

Paul Gregoire
via e-mail

The Handsome and the Lethal

The data in the sidebar "Just How Few Defended the Many?" ("Best of the Battle of Britain," Feb./Mar. 2008) seems to contradict those who would argue that the Hurricane was superior to the Spitfire. On a per-available-aircraft basis, the Spitfire shot down more enemy airplanes: 1.33, versus 0.97 per available Hurricane.

Undoubtedly, the Spitfire's greater speed and better canopy visibility had something to do with its greater effectiveness in combat.

Besides, the Spitfire was better looking.

Rudy Eskra
Pueblo, Colorado

John Fleischman writes of "Hitler's chilling 1934 debut of the Luftwaffe with its bristling array of swift, low-drag monoplane designs." The Luftwaffe's first fighters were the Arado 68 and Heinkel 51, both strut-and-wire biplanes. In other words, the German air force debuted with no technical superiority over future opponents. What it did have was a great propaganda department.

John R. Bernier Jr.
Spring Lake Park, Minnesota

Don't "Connie" Me!

"Connie's Comeback" (In the Museum, Feb./Mar. 2008) reminded me of a story I'd heard: When Eddie Rickenbacker ran Eastern Airlines, he had a fleet of Constellations with which he required his pilots to out-fly the competition. According to legend, Rickenbacker would say that calling the airplane "Connie" was like calling your mother "Babe."

Chuck Newton
Del Mar, California

The Connie in the photo on p. 57 ("Ed Maloney's Mission," Feb./Mar. 2008) is General Douglas MacArthur's personal transport, *Bataan*. I went through (and around, and all over) it during its short visit at the Planes of Fame's Chino, California facility in 1995, and was struck by how cozy the cockpit was for such a large aircraft.

Rainer Hanxleden
Colton, California

Cleaner Language

The caption for "New Recruit" (In the Museum, Feb./Mar. 2008) states that the Ryan PT-22 got its nickname, "Maytag Messerschmitt," due to excessive vibration. I flew a PT-22 for seven years and never noted that characteristic. More likely, the "Maytag" stems from the aircraft's history as a primary trainer: It was not as easy to fly as some were, so it made trainees fail, or "wash out."

Lee A. Brewer
Friday Harbor, Washington

Editors' reply: We've come across several explanations for the nickname, and haven't determined which is definitive.

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Letters

Combine Walt Disney, Willy Ley, and Wernher von Braun, and America's space ambitions were bound to expand.

Mr. B's Familiar Plan

"Mr. B's Big Plan" (Dec. 2007/Jan. 2008) brings to mind another "space program": a 1950s Walt Disney television series on spaceflight (above). Using the expertise of space scientists Willy Ley and Wernher von Braun as a foundation, Disney presented visions of space stations formed around inflatable cores: "The sections are carried...like folded balloons...they unfold when compressed air is put inside them."

Hank Caruso
California, Maryland

Countering Convention

"Fast Times at Sikorsky High" (Soundings, Feb./Mar. 2008) states that contra-rotating helicopter rotors date back to the 1920s designs of Corradino D'Ascanio (note the correct first name). In fact, Christian de Launoy and his mechanic, Bienvenu, demonstrated this approach on a flying model (like the X2, coaxial as well as contra-rotating) in France in 1784. The vast majority of helicopter prototypes from 1907 until Igor Sikorsky's VS-300 of 1939 used contra-rotating rotors. Jens Ellehammer, who made the first conclusively documented helicopter hover in 1912, used the coaxial, contra-rotating configuration, as did Raul Pescara, who made the first conclusively documented free helicopter flight in 1922.

Also, it's odd that the article neglected the X2's origins in Sikorsky's XH-59 Advancing Blade Concept (ABC) compound helicopter, which was also planned to have a pusher prop.

Roger Connor
Curator, Vertical Flight
National Air and Space Museum
Washington, D.C.

Bring 'em Down, Burn 'em Up

The nations of the international space community need to get together and come up with a way to de-orbit future satellites once they are obsolete ("Satellite Smashers," Feb./Mar. 2008).

A small solid rocket motor, not unlike those found in hobby shops, could be placed on future satellites to give them the little push needed to bring them down to burn up.

Large satellites that could survive atmosphere reentry should be designed so that their landing is contained within a safe area.

Steve Heye
Little Rock, Arkansas

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All letters selected for publication are edited. We reserve the right to publish letters in the magazine, on our Web site (*www.airspacemag.com*), or both. We regret that we cannot respond to every letter.

Brian Grote is a flight instructor with years aviation experience. He also writes monthly columns on subjects pertaining to aviation.

FLYBY

ARTICLE WRITTEN BY: BRIAN GROTE

Dear Brian,

I've been flying for over 20 years. My usual run is a Denver departure at 9pm, fly to Billings, on to Cheyenne and then back to Denver by 5am. I fly a King Air 350. I love my career and I pride myself on doing the best job I possibly can.

Last time out, however, I was making lots of little mistakes. I was cleared for the ILS Runway 35R into Denver, but I couldn't pick up ATIS. That's when I looked at my radios and noticed I had dialed in the wrong frequency. I glanced again and dialed in the right frequency. I continued through my checklist and set my Radar Altimeter to 5500 feet. I was ready to make my descent and start my approach. After the outer marker I glanced at my DH again and noticed that I had set my Radar Altimeter, 67 feet low. Luckily, I landed safely, bouncing the wheels just a little.

After a couple more days in the sky I could tell my eyesight was beginning to deteriorate. I knew I wouldn't be able to renew my first class medical if I didn't do anything about it. I was really worried and started asking my peers if there was anything I could do. A co-worker gave me a bottle of Claroxan™ and told me it would help me maintain my depth perception. I was skeptical at first, but tried it anyway. As it turns out, the stuff works great. The problem is, I ran out and don't know where to find more. Have you heard of this Claroxan™ stuff? Is it available in the States?

Jason, 46 – Seattle, WA

Jason,

Not only do I know of Claroxan™, it just so happens I take it everyday. Being a pilot myself, I know that perfect visual acuity is an asset none of us can afford to lose. That's why every pilot should be protecting their eyesight before it's too late.

Claroxan™ contains ingredients proven beneficial for the eyes. Among these ingredients are lutein and zeaxanthin – powerful antioxidants that have been clinically proven to protect the retina and macula and, in some cases, reverse the damaging effects of macular degeneration. These antioxidants block damaging UV rays and halt damaging free radical oxidation in the back of the eyes. They have also been clinically proven to decrease the risk of cataracts.

Claroxan™ also contains bilberry, an antioxidant known to improve night vision. Bilberry's night vision enhancing effects were first noticed in England in the early 1940's. The RAF ordered English fighter pilots to eat bilberry jam on toast figuring it would give them an advantage during night raid missions against the German Luftwaffe fighters.

Claroxan's unique proprietary formulation is completely safe, all-natural and extremely affordable. As far as ordering it, you can call them toll-free at 866.775.3937, or go to www.claroxan.com. I usually get mine within a week after ordering.

Hope this helps!
Brian

THE Himalayan CATARACT project

The Himalayan Cataract Project strives to eradicate preventable and curable blindness in the Himalayas through high-quality ophthalmic care, education, and establishment of a sustainable eye care infrastructure.

Based in Asia, at Kathmandu in Nepal, the Project is empowering local physicians to alleviate the suffering caused by blindness through unique programs including skills-transfer education, cost-recovery, research, and the creation of a world-class network of eye care facilities.

In years past, PacificHealth donated a portion of profits to HCP for development and construction of eye facilities in the Himalayas.

Visit CureBlindness.org to learn more about HCP.

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Claroxan™ may improve macular pigment density, which research shows has amazing effects on vision. By improving macular pigment density, ingredients in Claroxan™ may improve normal visual acuity, contrast sensitivity, and even glare reduction. Participants in one clinical study reported that ingredients in Claroxan™ improved their long range vision outdoors – in some cases, they were able to distinguish far away ridges up to 27 miles further than normal! Even if you have perfect vision now, Claroxan™ may help give you an edge by improving your visual reflexes and may allow you to pick up on moving objects faster than ever before.

People who count on their vision – people like pilots, hunters, military, and even pro athletes – trust Claroxan™ as the best source available for vision enhancement and protection. Claroxan™ is safe, effective, and extremely affordable. However, people with serious health concerns should consult a doctor before use.

Go Fish

DARPA sees the Flying Fish as a potential spotter in its Persistent Ocean Surveillance program.

Snack-seeking dolphins to Flying Fish UAV: "Is there enough to go around?"

>>> **WHEN THE** University of Michigan's unmanned seaplane, Flying Fish, crashed into the ocean off Monterey, California, during sea trials last December, a school of dolphins raced over to investigate. During the vehicle's test flight, the air data system, which measures airspeed and altitude, became plugged with salt; its computer, thinking the vehicle needed airspeed, put it into a dive, similar to those made by pelicans hunting for fish. The dolphins, eager to join the feeding frenzy, searched the area for almost a minute before going off hungry.

The UAV, the result of a project conducted by three of the university's engineering departments and funded by the Defense Advanced Research Projects Agency, is believed to be the first craft to autonomously initiate and carry out ocean-surface takeoffs and landings. Guy Meadows, director of the university's Marine Hydrodynamics Laboratories, came up with the design, which is loosely based on the 1940s PBY Catalina and Lockheed P-38 Lightning. "I think the twin-boom design is kind of ingrained in our heritage here at Michigan," says Meadows, in a nod to alumnus Clarence "Kelly" Johnson, later of Lockheed Skunk Works fame, who in 1933 received a master's degree in aeronautical engineering from the university.

The Flying Fish uses an onboard wireless video camera that can detect color changes—natural or man-made—in the water. Possible environmental applications include monitoring ocean spills and mapping river pollution; military uses might include monitoring submarines and relaying reconnaissance data to a manned vessel.

The team is already at work on a next-generation Flying Fish. Unconventional in appearance and dynamics ("It looks very much like a stingray might on the ocean surface," says Meadows), it is designed to survive a month on the ocean in eight- to 10-foot waves. "It has a much larger wing area than its predecessor, and the wing and body are meshed together so that it is far more of a lifting surface, as opposed to a conventional airplane with a fuselage or twin booms and a separate wing," says Meadows. Wind tunnel test flights will begin shortly.

REBECCA MAKSEL

UNIVERSITY OF MICHIGAN (2)

UPDATE

Glenn's Green Space

Coming soon to the village of Hammondsport, New York: Glenn Curtiss Memorial Park ("Glenn Curtiss Slept Here," June/July 2006). Town supervisor Richard Gardiner says that Hammondsport bought eight acres of lakefront property from developer Michael Doyle for $900,000 in anonymous donations. "It didn't cost the taxpayers anything," he told the *Star-Gazette* late last December. "It's a happy ending to a long, arduous effort on the part of many," park supporter Geoffrey Grimsman told the paper. "It couldn't happen at a better time. We're just about a year away from the centennial of Curtiss' *June Bug* flight."

Spin Cycle

"I really felt like I was launching into space," Richard Branson said after his simulator jaunt.

>>> SCOLDING A CALLOW youth named Luke Skywalker, hotshot space jockey Han Solo declared: "Flying through hyperspace isn't like dusting crops." Translated into 21st century terms, he might have said that the suborbital jaunts to be offered by commercial companies like Richard Branson's Virgin Galactic won't be like hopping a New York-to-Chicago 737. Suborbital adventurers will face the physical rigors of spaceflight previously endured only by career astronauts.

Getting them ready is the mission of the National Aerospace Training and Research Center, the first center dedicated to training civilian astronauts, which opened last October in an obscure corner of suburban Philadelphia amid strip malls and fast-food outlets. The NASTAR staff has parlayed years of experience designing and building centrifuges and simulators for NASA and the military into creating the STS-400, a human-rated centrifuge capable of serving as a sophisticated spaceflight simulator.

All of Virgin Galactic's future passengers are being prepped at the NASTAR on the STS-400, including Branson himself. "I personally trained him. He did rather well," says Glenn King, the NASTAR's chief operating officer. The NASTAR hopes to become the training center for all the companies looking to put paying customers into space.

Explains King, "This is not an airline flight. You're under some stress, some strain. Can most people cope with it? Yes, with proper training. You can't just walk in off the street, plunk down 200 grand, and expect to go up and do well."

What about the space geek who can't afford a ticket on Virgin's *SpaceShipTwo*? If he or she can pony up $3,000 to $5,000, the NASTAR offers a Sub-Orbital Space Launch Experience, in which any reasonably healthy adult can sign up for a one- to three-day instruction course culminating in a simulated suborbital flight. Strapped into the STS-400 cockpit, a trainee gets all the sights and sounds of an actual flight through computer graphics and other displays—while being spun up to a very real 3.5 Gs. For those who want to experience spaceflight without actually leaving the ground, that might be enough.

MARK WOLVERTON

HEADS UP

2008 American Barnstormers Tour

"These aren't airplanes, they're time machines," says tour organizer Clay Adams. Up to twenty 1920s and 1930s biplanes and monoplanes will tour the nation's heartland this summer, providing aerial parades and rides for $50 per passenger. Aircraft will be on display from 11 a.m. to 6 p.m. at each city's airport. Admission is free.

JUNE 15 & 16 Iowa City, Iowa Phone (319) 356-5045
JUNE 17 & 18 Ames, Iowa Phone (515) 239-5279
JUNE 19 & 20 Council Bluffs, Iowa Phone (712) 322-2287 or (712) 323-2173
JUNE 21 & 22 Hastings, Nebraska Phone (402) 463-5151
JUNE 23 & 24 Great Bend, Kansas Phone (620) 793-4168
JUNE 25 & 26 Wichita, Kansas Phone 1-800-435-9622 or 1-800-288-9424
JUNE 27 Emporia, Kansas (morning only) Phone (620) 342-3598
JUNE 27 & 28 Lee's Summit, Missouri Phone (816) 969-1186
JUNE 29 & 30 Jefferson City, Missouri Phone (573) 634-6469

www.americanbarnstormerstour.com

TOP: NASTAR® CENTER; LEFT: MIKE FIZER (2)

UPDATE

The Wisdom on Solomon

>>> JUSTIN TAYLAN, who has been cataloguing and researching World War II Pacific theater aircraft wrecks since 1993, was recently detained by the Royal Solomon Island Police Force, along with three colleagues, and charged with entering the Solomon Islands illegally ("Mystery on Guadalcanal," Dec. 2006/Jan. 2007). Last November the four explorers had come upon a salvage operation on Ballale Island. "We saw six Zero fighters, a Val dive bomber, and a Betty bomber being illegally removed," Taylan reported on his Web site, *www.pacificwrecks.com.* The group members pleaded innocent, saying they had crossed borders through a published port of entry and in accordance with Solomon Islands law. After a December trial, a magistrate pronounced them guilty on all counts. The maximum sentence was three years in jail; the magistrate instead imposed a total fine of $108. Says Ralph Wetterhahn, who wrote about Taylan's work for *Air & Space*, "I think the whole thing was orchestrated as a message for Taylan to stop mucking up the attempts by paying customers to steal wrecks."

O Canadarm

>>> CANADARM, THE Canadian-built robotic arm on the space shuttle and International Space Station, is going American. Under the terms of a proposed $1.3 billion sale, Minnesota-based Alliant Techsystems Inc. will take over the geospatial services division from Canadian parent company MacDonald, Dettwiler and Associates Ltd. The division includes Canadarm and RADARSAT II, an Earth observation satellite launched in December.

The arm, a source of pride for the Canadian space program, is used to capture satellites and support astronauts. Alliant hopes to use that technology to refuel spent satellites, a practice that shuttle astronauts pioneered in the 1980s. This time, Alliant would use Canadarm on an unmanned vehicle and control it from Earth.

Critics from two of Canada's opposition parties, the Liberals and the New Democratic Party, asked the ruling Conservatives to drop the sale in the name of Canadian sovereignty. "I personally feel it would be a mistake to allow the sale to go ahead because I think it is important for the company to be kept in Canada," says Marc Garneau, a Liberal candidate and past president of the Canadian Space Agency, "but I think it's important that we help ensure its continued viability." Due to concerns about a monopoly, the sale

JPL Stops, Smells Roses

CALIFORNIA'S JET PROPULSION LABORATORY, virtually the master of the solar system with its series of planetary probes, designed yet another stunning craft, this one for the Tournament of Roses parade last January in Pasadena. The float commemorated the 50th anniversary of the United States' first space mission, the launch of JPL's Explorer 1. Decorating a JPL craft's solar panel is a rendering of JPL's Explorer 1-era director William Pickering, astrophysicist James Van Allen, and rocket designer Wernher von Braun. Rising on Explorer's plume are a Martian orbiter, the Mars Science Laboratory (scheduled to launch next year), and JPL's Voyager 1, launched in 1977 and now well past Pluto, nearing interstellar space. At the moment, JPL has 19 spacecraft and six instruments dispersed throughout the solar system.

It's all done with black seaweed, eucalyptus leaves, ground walnut shells, daisies, roses, carnations, and crysanthemums.

TOP: NASA; LEFT: JPL

Handoff: In 2001, Canadarm 2 transferred its launch cradle to shuttle *Endeavour*'s Canadarm. Handoff 2: The Canadarm division has been sold to a U.S. company.

faces government reviews on both sides of the border.

Alliant assured Canadians that the point of the acquisition was to expand the business in Canada, and that the robotic arm will continue to feature Canada's red and white maple leaf flag. "There's no impetus to rebrand it," says Carl Marchetto, head of Alliant's space systems group. As a U.S. company, the former MDA division can now bid on classified U.S. programs.

ELIZABETH HOWELL

UPDATE

"No Parts for You!"

LAST JANUARY legislation took effect that prohibits the Department of Defense from selling F-14 parts at surplus auctions, closing the market to Iran, the only country that still flies the U.S. Navy fighter ("Persian Cats," Aug./Sept. 2006). Most of the 79 F-14s the U.S. sold to Iran in the 1970s are no longer airworthy, but an unknown number of fighters survive, in desperate need of parts. The U.S. ended diplomatic relations with Iran after the overthrow of its shah in 1979. Also prohibited is the granting of licenses for export of F-14 parts.

Clarence R. "Dick" Anderegg

DIRECTOR, AIR FORCE HISTORY AND MUSEUM POLICIES AND PROGRAMS

>>> **A FORMER F-4 FIGHTER WEAPONS SCHOOL INSTRUCTOR PILOT** and F-15 squadron commander, Dick Anderegg flew 170 combat missions during the Vietnam War. He is the author of *The Ash Warriors*, a history of the evacuation of Clark Air Base in the Philippines when Mount Pinatubo erupted in 1991, and *Sierra Hotel*, which discusses the cultural changes in the U.S. fighter force after Vietnam.

How do you think the Iraq and Afghanistan engagements will be seen by future historians? How will they will shape Air Force technology and culture?

The application of technology to the command and control of joint air services has improved dramatically. The Air Force sees this blend of joint combat power and combat control as the way to meet the needs of a joint forces commander. The ability to precisely strike targets has been superb, especially its ability to avoid collateral damage. Precision strike will be on the pages of every history that studies our combat in Iraq and Afghanistan. Whether technology drives culture or culture drives technology, they are in lockstep today.

In 1991, Anderegg conferred with his peers about the impending eruption of Mount Pinatubo.

USAF

What do you see as the greatest moments of Air Force history after its first 50 years?

As important as victories are the far-reaching changes the Air Force envisions. Fifty years from now, historians may view the formation of an Air Force cyber-command as an historical watershed. Formation of an organization that can organize, train, and equip cyber-warriors for presentation to the combatant commanders may alter the military in ways we can't even envision today. Cyber is a domain like any other – air, space, land, sea. Potential enemies will want to operate in it, so we must be able to dominate it.

How does the Air Force use history in its planning and policy?

The history program has historians at every Air Force base in the world. Presently I have eight historians serving in Iraq, Afghanistan, and Kuwait. Together this program produces 400,000 pages and supporting documents a year. Commanders at all levels use it to understand why and how decisions were made in the past so that they may make better decisions today. The value of history is that it teaches one the right questions to ask.

What was your role at Clark Air Base when Mount Pinatubo erupted?

First, it scared the devil out of me, so I was in pretty good company. The volcano was eight miles from the west side of the base, and it exploded 10 times as much ash as Mt. St. Helens. I headed the crisis action team, which planned our disaster response and directed the evacuation. We got 15,000 Americans off the base in six hours, and the first eruptions started 48 hours later. Too close, but thanks to a U.S. Geological Survey team the State Department sent, we had enough warning to get most away.

Visit *www.airspacemag.com* for the full interview.

Second, But Still Up

Vanguard (here, the 1958 launch) lost its bragging rights as "first" to Explorer 1.

AN HOUR BEFORE LIFTOFF, things were going as planned. The thousands of spectators who had converged on Cape Canaveral in Florida to witness America's first attempt to put a satellite in orbit were safely out of the way. The big gantry crane had withdrawn from the launch pad, and the wind speed, although high, was deemed acceptable. At T minus 45 minutes, photographers finished shooting the scene on the launch pad and put the caps back on their lenses. By T minus 30 minutes, anyone lingering near the blockhouse hustled inside. As the seconds ticked down, the rocket's umbilical cords dropped away, and the test conductor gave the command to fire.

And then, at 11:44 a.m. on December 6, 1957, Vanguard Test Vehicle 3 lifted briefly from the launch pad, collapsed, and burst into flames. The rocket's grapefruit-size satellite was thrown clear; with antennas bent and transmitters still beeping, "it lay on the beach next to the launch pad until somebody thought to collect it," says Michael Neufeld, chair of the space history division at the National Air and Space Museum, where the satellite is now on display.

Vanguard's unsuccessful liftoff "was a blow to United States pride and prestige," reported the *Christian Science Monitor*. *Time* magazine quipped that Project Vanguard should be renamed Project Rearguard, and jokes about the botched flight began circulating immediately. (Why is Vanguard like a civil servant? Because it won't work, and you can't fire it.) "In New York City," reported NASA's official Project Vanguard history, "members of the Soviet delegation to the United Nations asked American delegates if the United States would be interested in receiving aid under the U.S.S.R.'s program of technical assistance to backward nations."

Vanguard's aborted launch "gave the program a bad reputation that I don't think it really deserved," says Neufeld. "The Vanguard launch came after the success of Sputnik 1 and Sputnik 2, which was a one-two propaganda punch by the Soviets that was of great concern to the United States' leadership—and to many people in this country who were upset by the Soviets' achievement and that we had failed to launch a satellite on time."

Conservator Hanna Szczepanowska assesses the solar cells on a replica Vanguard satellite; the original will remain in orbit until at least 2109.

In 1955, the Naval Research Laboratory (NRL) was tasked with an unprecedented engineering feat: design, construct, and test a rocket that could place an artificial satellite, containing one or more scientific experiments, into orbit around Earth during the International Geophysical Year (1957-58). Staff and funding were cobbled together from government, military, and private sources. NRL astronomer John Hagen led the project. In little more than two years, the Vanguard team developed—from scratch—a three-stage rocket, a worldwide satellite-tracking system, and a serviceable launching facility.

As the United States waited for Vanguard to re-launch, the Army Ballistic Missile Agency launched Explorer 1, the first U.S. satellite, on January 31, 1958 (see "Then & Now," p. 76). Chris Hagen, son of Vanguard director John Hagen, remembers the event well. "I was a 13-year-old kid, and

LEFT: COURTESY OF RONALD MULLER; TOP: ERIC LONG

all my friends were saying, 'Why isn't your daddy's satellite up?' And then the first Explorer went up. I said something—because I was a competitive kid—I said 'Phooey, rats, darn.' Dad looked at me, smiled and said, 'No, this is a good thing.' The idea of a race between the Vanguard group and the Explorer group was secondary to getting a satellite up."

On March 17, 1958, Vanguard 1 blasted off against a sunny sky and sent its satellite into orbit, circling Earth every 107.9 minutes. Amateur stargazers, inspired by director Hagen's enthusiasm, gathered on hilltops and in open fields to track Vanguard with their telescopes, transmitting their data to the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts.

The data received from the little satellite was significant. It helped establish that Earth is more pear-shaped than round, provided scientists with information on the density and temperature ranges of the atmosphere, proved that a satellite could be powered by solar energy, and helped cartographers improve the accuracy of world maps.

Vanguard continued to transmit data for seven years, and while Sputnik reentered Earth's atmosphere sometime in 1958, scientists say that because of its solar cells, Vanguard will remain in orbit until at least 2109.

In addition to the satellite that failed to leave Earth in December 1957, visitors to the National Air and Space Museum can see a backup satellite from the successful March 1958 launch. Both are located in the Museum's Space Hall, where they serve as important reminders of American ingenuity and persistence.

REBECCA MAKSEL

Visitor Information

Family Days Celebrate 400 years of the telescope on April 12 at the Steven F. Udvar-Hazy Center in northern Virginia, where curators will be on hand to talk about how telescopes are made, and how to select and use one of your own. Admission is free; the event runs from 10 a.m. until 3 p.m. On April 19, at the National Mall Building, examine methods used to study the night sky throughout the ages, and learn about early Native American astronomy. The event runs from 10 a.m. to 3 p.m.; admission is free. On May 3, commemorate NASA's 50th anniversary – and past achievements – and celebrate the agency's future opportunities at Space Day at the National Mall Building. The event runs from 10 a.m. to 3 p.m., and admission is free.

What's Up Receive regular updates on Museum events, read about artifacts, and get detailed exhibition information by subscribing to the National Air and Space Museum's free monthly e-newsletter, *What's Up*. Sign up at *www.nasm.si.edu*.

National Air and Space Society Members of the National Air and Space Society are charitable donors who support the mission and programs of the National Air and Space Museum. Society membership offers advance access, invitations to special events in the Museum, and other benefits. Like *Air & Space* associate members, National Air and Space Society members receive *Air & Space* magazine and discounts. Unlike associate members, Society members' contributions help fund the Museum's restoration, preservation, and education efforts. Both memberships support the Smithsonian Institution. For more information, visit *www.nasm.si.edu/membership*.

ARTIFACTS

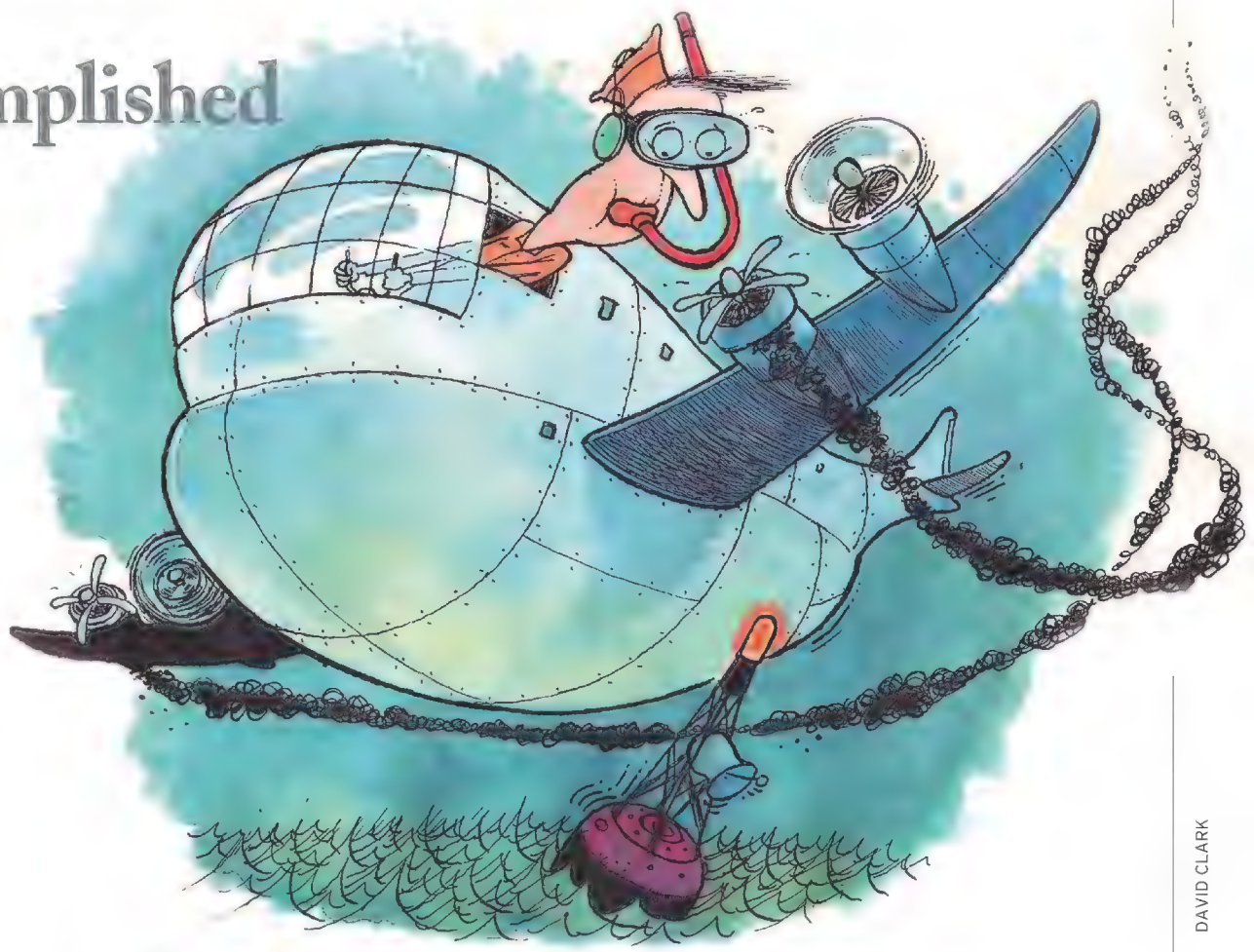
Spurned Hero

KNOWN FOR HIS brilliant air campaigns and his impolitic remarks (he once contended that his superiors ran the fledgling U.S. Army Air Service with as much knowledge "as a hog has about skating"), Brigadier General Williiam "Billy" Mitchell led nearly 1,500 British, French, and Italian aircraft in the September 1918 Battle of Saint-Mihiel, in France, one of history's first coordinated air-ground military offensives. Mitchell's aviators – whom he referred to as "independent cavalry" – helped capture Saint-Mihiel from the Germans in 36 hours. A passionate advocate of a separate air force (one that could carry out operations against enemy targets rather than supporting frontline troops), Mitchell felt that U.S. airpower would protect the nation's coasts better than existing seapower. Increasingly critical of AAS leadership, Mitchell was court-martialed in 1925 and suspended from duty. Later considered a visionary, Mitchell was posthumously awarded a Congressional Medal of Honor for his service.

ERIC LONG

The campaign hat, riding boots, and spurs (on loan from the National Museum of the U.S. Air Force) worn by Mitchell in 1918.

Mission Unaccomplished



DAVID CLARK

ON A JANUARY NIGHT in 1969, I strapped into the right seat of a Pennsylvania Air National Guard Boeing C-97 at Travis Air Force Base in California for the next leg of a two-week odyssey from our home at Willow Grove Naval Air Station to Cam Rahn Bay in South Vietnam. We went through our checklists for a late-night takeoff for the next stopover, at Hickam Air Force Base in Hawaii. I was a new second lieutenant, six months out of pilot training, still mastering where all the circuit breakers were and remembering to check that the floor hatch to the lower deck was closed before I stepped into the cargo area.

The C-97 was a derivative of the B-29 bomber, with the fuselage sliced in half longitudinally and a fatter second deck added on top to make the aircraft more suitable for cargo than for bombs. It had the same engines and wings, and a glass greenhouse for the flight deck, which made for great sightseeing or a 100-degree oven when transiting the tropics at low altitude. Its propellers were driven by four 3,500-horsepower Pratt & Whitney R-4360 Wasp engines that were the culmination of piston-engine technology before jet engines appeared. With engines being driven to their limits, they failed much more frequently than today's jets. As a result, crews unaffectionately called the C-97 the Boeing Tri-motor.

For missions across the ocean to short, hot atoll runways, the norm was 195 mph cruise at 10,000 feet. The range, about 2,760 miles, was typical for four-engine prop jobs of the era, and complemented the Almighty's placement of those infinitely small coral islands across the Pacific. Our leg to Honolulu, 2,415 miles, remains the longest open-water stretch in aviation. In the middle you are more than 1,150 miles from the nearest speck of dirt.

Soon we were well out to sea, sharing our Pacific skies with a billion stars. At 8,000 feet we listened enviously to the position reports of the C-141s and C-135s far above us, doing in four hours what would take us more than 10. As we approached the equal time point—the halfway mark—which in those days actually was marked on the sea by a Coast Guard ship, *Ocean Station November*, one of the 28 cylinders in the number-four right outboard engine blew a crack in its head. This required immediate feathering of the propeller—turning the blades to an angle that minimized drag—before the oil pressure in the amazingly complex prop dome dropped too low to drive the prop to the feather position. If you failed to do this, the prop would windmill at increasingly higher revolutions per minute until the shaft sheared off, flinging the prop free and too often in the direction of the fuselage, a scenario that had already brought a few C-97s down.

We feathered the prop and finished the checklist. No sooner were our emergency procedures completed than the loadmaster came forward and told us sparks and flames were coming out of the nacelle of the left inboard engine. Later investigation would show that the starter shaft had sheared—not at the designed shear point, near the drive gear, but at the far end of the shaft. Now we had a shaft rod flailing around in the cowling, threatening to gouge the cowling innards clean. We cut that engine to idle so that the remnant would be sheared off or would no longer scour the innards, but the engine was no longer putting out power. We were now a Boeing Bi-motor. We were headed back to San Francisco, and we were at the one place in the world most remote from any land.

Just flying the airplane became an ordeal. With our load we couldn't hold altitude on the remaining two engines, even at full throttle. The asymmetry of thrust made full rudder trim inadequate, so one of us had to hold constant and considerable pressure on

the rudder to keep us straight. It was only when we got down to 1,000 feet that we were able to hold altitude with full bore on the throttles, but it was not likely that we could keep those engines and props going at takeoff power for the four-plus hours back to landfall. A night swim in the north Pacific looked like a sure thing.

Ocean Station November, normally a quick fix and a position report, became the communication lifeline for our Mayday call and request for a launch of a Coast Guard rescue HC-130 Hercules out of San Francisco. As we struggled eastward, they would head west to intercept us and prepare for our ditching.

Every moment was consumed by some pre-ditching preparation: raft breakouts, crew duty assignments, navigator position updates (this was pre-GPS—navigators did it the Polynesian way, with the stars). Amazingly, the overworked props kept turning, and after a couple of hours the fuel burnoff allowed us to throttle back a wee bit. As the right-seater, I spent a lot of time setting up for the water egress from the right side of the airplane and copying the elaborate ditching brief from the Coast Guard escort, who was now in UHF radio range. I was fascinated by the catalogue of services the Coast Guard was going to provide: data on swell direction, sea state, winds, and wave heights; laying down a flare trail on the sea for a pseudo-runway; dropping a raft for us.

I also remembered my checkout training, just six months earlier, in which the instructor pointed out that the C-97 was a "good" ditching airplane, averaging 11 minutes of float time. That was marginally comforting. After a Pan Am Stratocruiser—the commercial version of the C-97—ditched at *Ocean Station November* in 1956, all passengers were rescued, but that was in daylight and on calm seas. Then I recalled the instructor also said a C-97 that had ditched off the Azores floated for 10 days until it was deliberately sunk as a hazard to shipping. It wasn't rocket science to compute that 10 days factored into that 11-minute average meant those other C-97s must have sunk like stones.

We rendezvoused with the Hercules about 500 miles out. At least now we would have company, and somebody would know where we went in. Then a weather update added a new issue. From the coast inland, the San Francisco Bay area had an 800-foot overcast, and the shortest path from the Farallon Islands—27 miles off the coast—to San Francisco would go right past the city's 900-feet-tall Twin Peaks, their tops penetrating the overcast, and we still weren't in a position to climb. We decided to head for the Golden Gate Bridge. We could see its lights under the coastal clouds, and could break it out on the radar. After that it was a right turn down the bay to San Francisco. Ditching now would be no harder than breaking out of Alcatraz.

After getting clearance from San Francisco tower for any approach, a look eastward across the bay revealed the lights of Travis Air Force Base in the clear, with an inviting straight-in approach to an 11,000-foot runway. We proceeded to Travis with a grateful wave-off to our new Coast Guard friends, and landed, on wheels and tires, nice and dry.

Only when we got down to 1,000 feet were we able to hold altitude with full throttle, but it was not likely that we could keep engines and props going at takeoff power for the four-plus hours back to landfall. A night swim in the north Pacific looked like a sure thing.

It took two days to replace the number-four engine and repair number two. Then we were ready to try again to make the run to Cam Rahn Bay with fresh cargo, this time with me in the left seat. As I pulled back on the yoke and lifted the nosewheel off, a loud bang and a huge flame erupted from the lower corner of the windscreen, followed by a dazzling electrical arc. We aborted the takeoff.

With the aircraft slowed and under control, we saw that the little phenolic block that was the plug for the window electrical heater had shorted out and melted. It also set on fire the nylon escape rope used to lower yourself out that window in case of fire. Back to the ramp for another repair.

Getting a new windscreen from home station would take days, so we asked a guy from the sheet metal shop if he could make a replacement for the melted plug. We gave him the glob and he looked at it with a somewhat puzzled expression, then said he'd give it a try.

The next morning the sheet metal guy drove up, jumped out of the truck, and proudly handed us the replacement, saying that he was up most of the night making it. It was a perfect copy—not of the original rectangular block, but of the melted blob we had given him. We called it a day and arranged for a new window from home station.

Having now used up most of the two weeks our citizen airmen had taken from their civilian jobs for this trip, we gave up and headed back home to Willow Grove the next day. Somewhere over one of those flat states in the middle of the country we ran into thunderstorms and got struck by lightning. By now such events were anticlimactic. All engines kept running, nothing was on fire, and a whole continent was beneath us. The yellow caution and warning lights blinked off. We yawned and continued home to Pennsylvania.

While I was changing clothes in the pilots' locker room for my drive home, the training officer popped in and asked if I was still interested in the simulator emergency procedures refresher I had put in for the following week. "Never mind," I told him, "I just completed the long course." The next year I transitioned from many-motors to single-engine fighters. It seemed a lot safer. At least I wouldn't have to worry about losing two engines again.

WILLIAM CAMPENNI

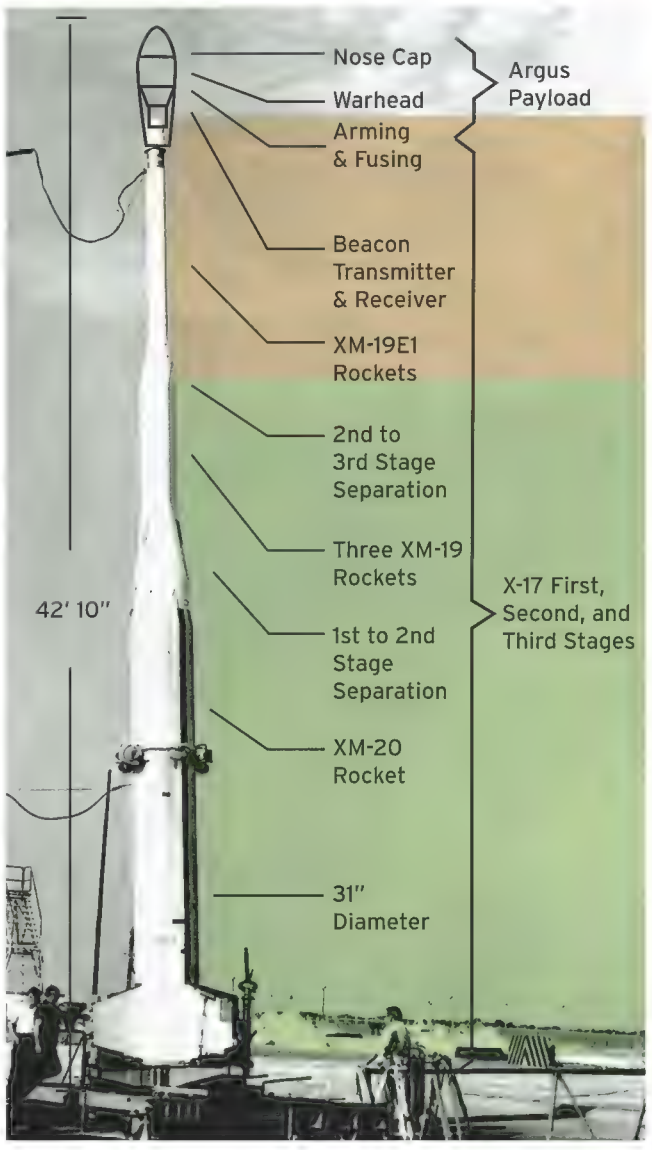
Homebuilt Radiation Belt

WHEN THE SOVIET UNION launched Sputnik in October 1957, the United States feared that nuclear missiles would soon follow. How could we stop them? In the Dr. Strangelove era, no idea was too absurd, and Nicholas Christofilos, an elevator engineer turned nuclear physicist, had a doozy.

Christofilos had only undergraduate degrees in electrical and mechanical engineering, but he had become a top military scientist at California's Livermore Laboratory with a reputation for audacious creativity. He suggested that an atomic explosion in space could generate a vast flux of electrons, which would form a shell of energy over Earth, a phenomenon that became known as the "Christofilos effect." The result, Christofilos suggested, might fry Soviet warheads.

A recent high-altitude test had already demonstrated how a nuclear blast could disrupt ground-based electronics, but the Christofilos effect, it was theorized, could create a defense: The speeding electrons trapped in Earth's magnetic field would produce radiation that might disrupt the arming and fusing mechanisms of enemy warheads. When the first U.S. satellite, Explorer 1, detected the Van Allen radiation belts surrounding Earth in January 1958, Christofilos' ideas seemed even more plausible.

The Atomic Energy Commission put together a plan to detonate small atomic weapons above the atmosphere to create the Christofilos effect for study. Time was crucial, because in the fall of 1958 a potential moratorium on atomic testing loomed. Argus was up and running in only five months, and by early August 1958, the nine ships of the U.S. Navy's Task Force 88 were heading for various points in the Atlantic Ocean.



Lockheed X-17 rockets launched the Argus nuclear tests, which the *New York Times* described as the "greatest scientific experiment ever conducted."

Three Lockheed X-17A three-stage missiles, each modified to carry a 1.7-kiloton W-25 plutonium warhead, would be fired from the USS *Norton Sound* in the south Atlantic, a remote locale chosen for its windswept winter, which assured there would be no activity in the vicinity. Just before 2:30 a.m. on August 27, the first nuclear weapon to be launched from a ship left the deck of the *Norton Sound.*

A third-stage failure resulted in a nuclear detonation at a lower altitude than planned, but the explosion seven minutes later was high enough to partially confirm the Christofilos effect. The Task Force 88 team watched in awe as a brilliant flash spread across the horizon, and a pale red glow transformed into an eerie, greenish-blue aurora high above, forming glowing streamers along the direction of magnetic north and south.

Two more launches followed on August 30 and September 6, while the latest U.S. satellite, Explorer 4, probed the results. Explorer 4 had been launched just before Argus began—publicly to further investigate the Van Allen radiation belts but secretly to also analyze the Argus experiments. James Van Allen's instruments, along with measurements from ships, airplanes, and sounding rockets, confirmed Christofilos' predictions. The Argus explosions had indeed created artificial radiation belts around Earth.

But hopes that the Christofilos effect would provide a defensive shield against Soviet missiles faded quickly. The electron belts created by the experiments were too weak and transitory to do much damage to enemy missiles that would pass through them at thousands of miles per hour. Christofilos, dubbed "the Crazy Greek" by the press, continued to explore ideas (some of which are still classified) until his death in 1972.

Fifty years after Argus, however, the Crazy Greek doesn't seem quite so crazy. Space-based nuclear tests in the early 1960s proved that the Christofilos effect could disable satellites. Now that near-Earth space harbors hundreds of satellites of critical economic and military importance, strategists are considering the Christofilos effect anew. Even a technologically humble rogue state could launch a missile and detonate a low-yield nuke high over its territory, creating a Christofilos effect that would cripple the satellites of its more sophisticated rivals.

MARK WOLVERTON

NATIONAL MUSEUM OF THE USAF

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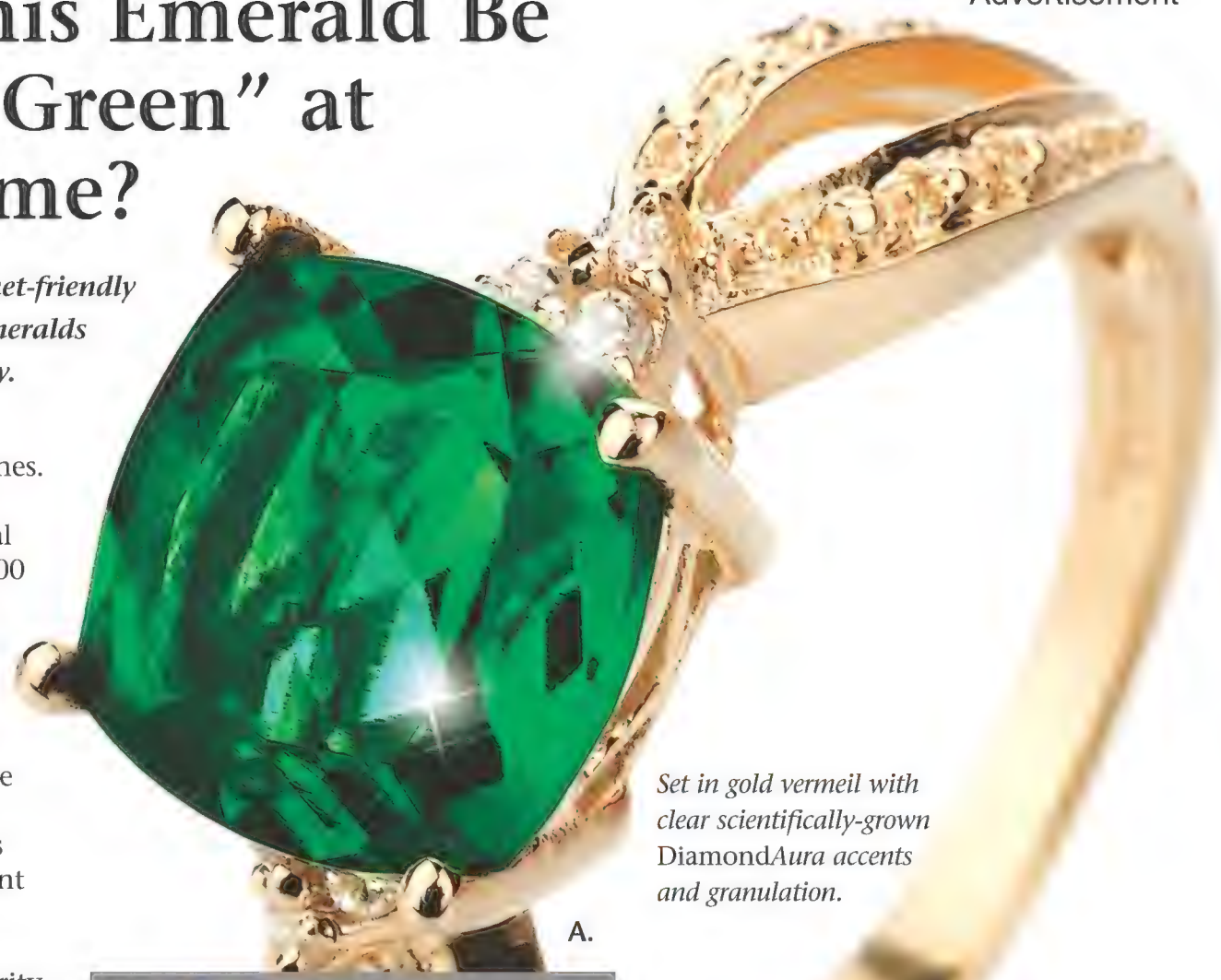

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SCHOOL OF HARD ROCKS

LONI HABERSETZER TEACHES PILOTS HOW TO LAND ON THE HARSHEST TERRAIN.

BY TOM LeCOMPTE **PHOTOGRAPHS BY CLARK MISHLER**

Flying his Piper Super Cub through the Alaskan wilderness, Loni Habersetzer has sharpened his skills as both a pilot and an outdoorsman. Opposite: Habersetzer puts down on a gravel bar only 300 feet long; "If I mess up," he remarks, "I'm in the river."

FROM A THOUSAND FEET, THE ALASKAN TUNDRA IS A VERDANT LANDSCAPE broken only by rivers winding down to Bristol Bay. Loni Habersetzer banks his Piper Super Cub steeply over one of the rivers. He circles once, twice, then descends for a closer look.

What's the matter?

The airplane is now low over the water, the wingtips seeming to brush tall spruces nearby. Habersetzer turns to follow a sharp river bend. He's found a place to land, he tells me.

Ahead is a bar covered with pieces of driftwood and boulders the size of basketballs.

Land?

Habersetzer cuts back the power. The airplane's tires skim water, throwing up rooster tails of spray.

We're not landing, we're crashing.

The airplane bounces up onto the bar and jolts to a stop. Habersetzer turns to me. "Great, isn't it?" he asks, grinning.

Habersetzer specializes in landing on difficult places: narrow gravel bars, steep mountain slopes, rock-strewn glaciers, rough beaches, muddy bogs, stamp-size clearings. Depending on the conditions, he can land and take off in an area as small as 100 to 150 feet, a little more than five airplane lengths. Other bush pilots land and take off from challenging terrain, but they do it for practical reasons, to deliver cargo or carry passengers to and from remote areas. Habersetzer flies into unwelcoming places purely for sport, pushing the limits of his ability and the performance envelope of his airplane.

Habersetzer shuts down the engine. The only sound is that of the river rush-

On an early-morning flight over the upper Mulchatna River (above), Habersetzer watches for caribou (left). When it comes to landable terrain, the view does not look promising.

ing by. He gets out of the airplane and surveys the rock bar, pacing its length. It is barely longer than a railroad boxcar. Habersetzer knows within just a few feet the length he needs for takeoff. Here, he will run out of solid ground, but by that point he thinks he will have enough speed and enough lift under the wings for the airplane to safely hydroplane along the water until he can get it airborne.

Habersetzer clears a couple of large rocks and a log, then walks back to the airplane. After starting up the engine, he applies a careful combination of throttle and rudder to gently swing the airplane around. Then he again powers the engine to lift the tail before releasing the brakes. In a couple of bounces he's at the end of the bar. The airplane briefly skims along the water, then lifts into the air.

A man with a gentle, easygoing manner, Habersetzer does not appear to be bent on self-destruction. Lanky and tall and wearing wire-rim glasses, he looks almost bookish. Born in Vancouver, "*Warsh*ington," as he pronounces it, Habersetzer practically grew up in a Super Cub, and he has never flown any other type of airplane. He soloed in his father's as a teen. After high school, he supported himself working for his father's electrical contracting business; on weekends he built up his flying hours, and later he began spending summers flying for an Alaska hunting lodge and guide service.

Like most Cub pilots, Habersetzer learned the traditional method for landing a taildragger: Line up with the runway, cut the power, then glide until the airplane touches down softly to a three-point landing, in which the tailwheel and the main-gear wheels all touch at the same time. It is, says Habersetzer, a perfectly fine way to land, if one has the real estate. But he found that the traditional method has two big drawbacks. First, the wind and other conditions will make you land on a different spot every time, and some-

FIND OUT MORE www.airspacemag.com WATCH A CLIP OF HABERSETZER'S TIGHT-SPOT TECHNIQUES.

times, Habersetzer wanted more precision, especially when he saw a good spot for hunting or fishing. Second, once the tailwheel touches, you lose nearly all forward visibility, a dangerous situation when you're in close to objects like rocks and trees.

"I met a guy from Alaska who had quite a bit of bush flying experience," Habersetzer says. Instead of gliding, this pilot flew a power-on approach, slowing the airplane to the verge of a stall, then using the throttle to control the rate of descent and the elevator to control pitch and thus airspeed. By flying "behind the power curve," Habersetzer explains, he could drop his airplane on the exact spot he wanted.

than full-on flaps and thus enables a shorter takeoff run. And he figured out how to perform a "water-assisted" landing, in which he slows the airplane by skimming the tires along a stream or lake before rolling onto solid ground.

Habersetzer insists that he's no daredevil, that what looks crazy is in fact the result of careful planning and a lot of practice. "If there is any doubt [about being able to make a landing]," he says, "I'm just not interested in doing it."

When he finds a new place to land, the first thing Habersetzer does is double-check his position—that is, in which direction he will need to hike should he become stranded. He then checks out the airspace above the strip, descending in 300-foot intervals. During this survey, he determines the approach to the strip and checks for obstacles such as trees or power lines. In addition to the length and width of the strip, he pays attention to its surface. He may "drag" the strip, flying its length and letting the airplane's tires roll along the surface. Before deciding whether he will land, Habersetzer may overfly a strip as many as 15 times.

After we've been flying for a while,

Costing about $3,400 a pair, Habersetzer's hand-made, Kevlar-reinforced tires are inflated to only 4 pounds per square inch. His have endured about 10,000 landings.

HABERSETZER SAYS HE'S NO DAREDEVIL, THAT WHAT LOOKS CRAZY IS IN FACT THE RESULT OF CAREFUL PLANNING.

Nothing special there. It's the same technique naval pilots use to land on carriers. The revelation to Habersetzer was that the technique doesn't just let him put the airplane right on the spot he wants, it also enables him to keep the tail up longer, which improves visibility.

Habersetzer honed his skills, hopscotching from one landing strip to another, sometimes making as many as 30 or 40 landings in just a couple of hours. Gradually, he added his own touches to the power-on method. He found that by putting 30 pounds of weight in the tail section, he can brake harder after touchdown without flipping the airplane on its back. He learned to use his GPS unit to determine groundspeed on touchdown so he can calculate his rollout distance. He discovered that during his takeoff roll, applying flaps in increments results in less drag

Habersetzer lands on the crest of a low ridgeline. It is a comparatively easy strip: mostly flat, unobstructed by trees, the ground free of large obstacles—perfect for practicing. Habersetzer places a set of caribou antlers off to the side to mark a touchdown point. We take off and Habersetzer sets up for approach. With constant manipulations of the throttle, he works to keep his speed over the ground at 43 to 45 mph. "A one-mile-per-hour difference in groundspeed can mean another 25 to 50 feet to stop," Habersetzer says.

Just as he is alongside the antlers, he cuts the power, dropping the airplane onto the surface. The wheels roll over the gravelly surface and he pumps the brakes to bring the airplane to an abrupt stop. Habersetzer checks his rollout distance: a little over 120 feet. Not satisfied, he decides to go around for another approach.

Much of what he does, Habersetzer explains, depends on the equipment he flies. The Super Cub, with its large wing, its high power-to-weight ratio, and its tough, simple design, is ideal for backcountry flying, a fact Cub drivers have known since the airplane's 1949 rollout. And "the airplane is so responsive you almost wear [it]," Habersetzer says. "You get a lot more feedback from the controls."

Just as important are the tundra tires (Habersetzer never flies with skis or floats). They are larger than normal tires, and kept at low air pressure, so they don't roll over obstacles as much as through them. Manufactured by Alaska Bushwheel at a tiny factory in Joseph, Oregon, the tires come in several sizes and sell for as much as $4,500 per pair.

SAYS ONE TIRE MAKER: AIRPLANES LIKE THE SUPER CUB ARE BECOMING THE NEW SPORT UTILITY VEHICLE.

Once marketed primarily to commercial operators in Alaska or Canada, the tires are now sold to all kinds of pilots, around the world. As more recreational pilots discover the pleasures of off-airport flying, says Alaska Bushwheel president Bill Duncan, airplanes like the Super Cub are becoming "the new sport utility vehicle," and tundra tires as much a status symbol as a practical necessity.

Other necessities, says Habersetzer, are a shovel, a saw, and a good axe, in case the pilot finds himself needing to extend his runway. "At that point, you have all the time in the world," he says. When Habersetzer's airplane got bogged down in the mud once, he spent the afternoon cutting down spruce trees to lay down for an impromptu strip.

In 2003, having noticed that backcountry flying was becoming increasingly popular, Habersetzer decided to start teaching his techniques to other Super Cub pilots. He began his own business, Cubdriver749er (based on his airplane tail number, N82749). Not being certified by the Federal Aviation Administration as an instructor, he cannot offer dual instruction in his airplane, so students have to be licensed pilots and provide their own Super Cubs. Habersetzer offers courses in Alaska, in Washington state, or at a pilot's home, in packages starting at $1,500.

At the beginning of his course, he sits down with his student and describes his flying techniques. He then demonstrates them in his Cub while the student rides as a passenger. Finally, the student solos an approach in his own airplane, while Habersetzer talks to him via radio. At each step, Habersetzer ratchets up the challenge, advancing through the basics of landing on rough surfaces, steep slopes, and soft sand or mud.

Just as important, Habersetzer spends a lot of time telling students what *not* to do—for example, not being tempted by a spot that has enough room for landing but may not have enough for takeoff. By the end of the course, Habersetzer explains, students should have the ability and confidence to go out and learn on their own.

One Habersetzer alumni, Shaun Lunt, praises his instructor's example: "Loni's very consistent, very smooth," he says. Lunt, a 33-year-old anesthesiologist from Loma Linda, California, is a 12-year pilot who, after working his way up the ratings and endorsements—private, instrument, commercial, floatplane, aer-

SHAUN LUNT

Habersetzer and two students land to transfer fuel. The rocky site is about as good as it gets on this stretch of coast (in the background: a chunk of the Aleutian Range).

Habersetzer operates out of Marabou Landing, a lodge about 230 miles southwest of Anchorage. In addition to teaching, Habersetzer leads guided adventures and hunting trips. Below, the pilot (at left) and the author plan a flight (left).

obatics—decided he needed a new adventure. He co-owns a Cirrus SR-22, and last winter he bought a Super Cub with the intention of flying it to Alaska. "I have a passion for the outdoors, and bush flying was something I had been interested in doing," he says. Last May, he flew to Alaska to take the course. "I had flown on skis and floats, but nothing this demanding," he says. "It's a very aggressive way of flying, very precise."

The most valuable aspect of Habersetzer's instruction, Lunt says, "is that you get the benefit of a lot of experience that would have taken a lot of time and a lot of mistakes to learn otherwise.... It takes a lot of the 'school of hard knocks' out of it."

Early on in his instruction business, Habersetzer had thought about making a video, something that might entertain as well as get his service some exposure. He had seen some other backcountry flying videos; he thought he could do better. But knowing nothing about video production, he shelved the idea. Then in 2004, friend and flying partner Greg Miller asked Habersetzer for help making a short video for a line of custom tires Miller was going to promote at the annual Alaskan Airmen's Association convention. "I had Loni shoot me bumping around a few places," Miller recalls. "It was basically a seven-minute loop, something to draw a little attention to the product in the display booth." The video ended up being the talk of the show. "I had people lined up outside the tent," Miller says. "People who had been flying 30 or 40 years in Alaska who came up to me to say they had never seen anything like it—and these are people who you'd think would be blasé about the whole thing."

Thus inspired, the two spent a couple of months in 2004 shooting video of themselves flying in the mountains. "The production quality was pretty rough," Habersetzer admits, "with just some hand-held camera from the ground and some air-to-air shots, along with some shots [from a camera] mounted on the fuselage of the airplane." Watching it, I was reminded of TV footage of snowboarders careening down mountainsides and kayakers paddling over waterfalls. Released on DVD in 2005 with a title only Freud could love, *Big Rocks and Long Props* has sold nearly 5,000 copies—an impressive number, considering the filmmakers have done no advertising or promotion, and have sold copies almost solely via the Internet. A second DVD came out last year, and Habersetzer has recently finished a third, on glacier flying in Alaska.

"It's opened a lot of opportunities for me that I never would have expected," Habersetzer says. Since the videos came out, pilots in Kenya and Mexico have paid him to come teach them his techniques, and he will be traveling soon to Israel and New Zealand to instruct more pilots. His customers are, like him, in it for the challenge.

It's late now, and as the sun drops, long shadows stretch across the landscape. Habersetzer heads toward another low ridge of hills. The ground quickly rises toward the airplane, but he makes no attempt to climb. He adds a notch of flaps. Then he suddenly adds power and pulls the airplane up. The Cub is following the grade of the hillside, and as it loses speed, it nears the ground. With a gentle bump, it touches down, rolling to a stop just as the hill peaks.

A Place

IN THE FALL OF 1958, A YEAR after the Soviet Union had launched Sputnik, Americans wondered what NASA, their new space agency, would pick as its goal. The moon? Mars? A wayward asteroid? Few were prepared for the call that came in October, just weeks after the agency's formation, when the National Research Council's Space Science Board recommended that one of NASA's first priorities should be the sun.

But only now—almost 50 years after the board's report—is NASA seriously considering building a probe to send very close to the sun: a 2015 launch of a $750 million spacecraft. Why has it taken so long?

In the past, "nobody paid much attention to [the probe idea] because we didn't know how to do it," said Marcia Neugebauer, an adjunct research scientist at the University of Arizona's Lunar and Planetary Lab who spent most of her career at NASA's Jet Propulsion Laboratory (JPL). "We didn't have any rockets that could come anywhere close to [delivering] a solar probe. Then [Italian mathematician] Giuseppe Colombo came along and suggested that a Jupiter flyby could put you on a trajectory to the sun."

In the mid-1970s, an informal group at JPL started working on an unofficial effort to use a Jupiter gravity assist to send a probe on a suicide mission into the sun. The project, dubbed "an arrow to the sun," would have been a bare-bones effort, with no costly imagers and only minimal instrumentation. Its goal was to measure the properties of solar particles before they hit interplanetary space.

NASA's probe will investigate one of the last unexplored regions of the solar system: the sun's atmosphere, or corona.

Any data it would relay would have been sent back in real time; there would have been no second chances to gather more before the probe burned up as it approached the sun.

Critics of such suicide missions say that a wider range of information could be obtained through multiple close flybys. Spacecraft could measure the solar wind plasma near its origin and map how the corona, the sun's outer atmosphere, expands in the form of a hot, magnetized stellar wind. Although the Ulysses, Helios, SOHO, and Voyager spacecraft have explored the solar wind, the closest any spacecraft has come to the sun is 65 solar radii. In contrast, the proposed 2015 solar probe will come within 9 radii, well within the outer limits of the sun's corona. (One solar radius is some 431,000 miles, or almost twice the distance from Earth to the moon.) Learning about the genesis of the solar wind is crucial because satellite communications as well as future manned exploration missions are largely at its mercy. Coronal Mass Ejections (CMEs), huge bubbles of magnetized gas that burst from the sun over the course of several hours, whip up solar winds whose high-energy radiation can disable telecommunications satellites. Astronauts outside Earth's magnetosphere—on the moon, for instance—are also vulnerable.

Another part of the puzzle is astrobiological. Is our solar system and the star at its center somehow different from the rest of its stellar brethren? Our sun, on average only 93 million miles away, is considered a run-of-the-mill yellow dwarf, a typical yellow star that is in the process of converting hydrogen to helium by nuclear fusion in its core, and is roughly halfway through its estimated 10-billion-year lifespan. Do other planetary systems

in the Sun

Earth dwellers view the sun from 93 million miles away. What will NASA's next solar probe see from the inside? BY BRUCE DORMINEY

have yellow dwarf stars at their centers, and if so, do the planets orbiting them resemble Earth? "We deduce that other stars have coronas like ours, and we can see variations that can be interpreted [to be] solar cycles like ours," says Ralph McNutt, a space physicist at Johns Hopkins University's Applied Physics Laboratory and a member of NASA's science and technology definition team for the probe. "One of our questions is, if you have a yellow G dwarf star, do you always have a solar corona and a solar wind?"

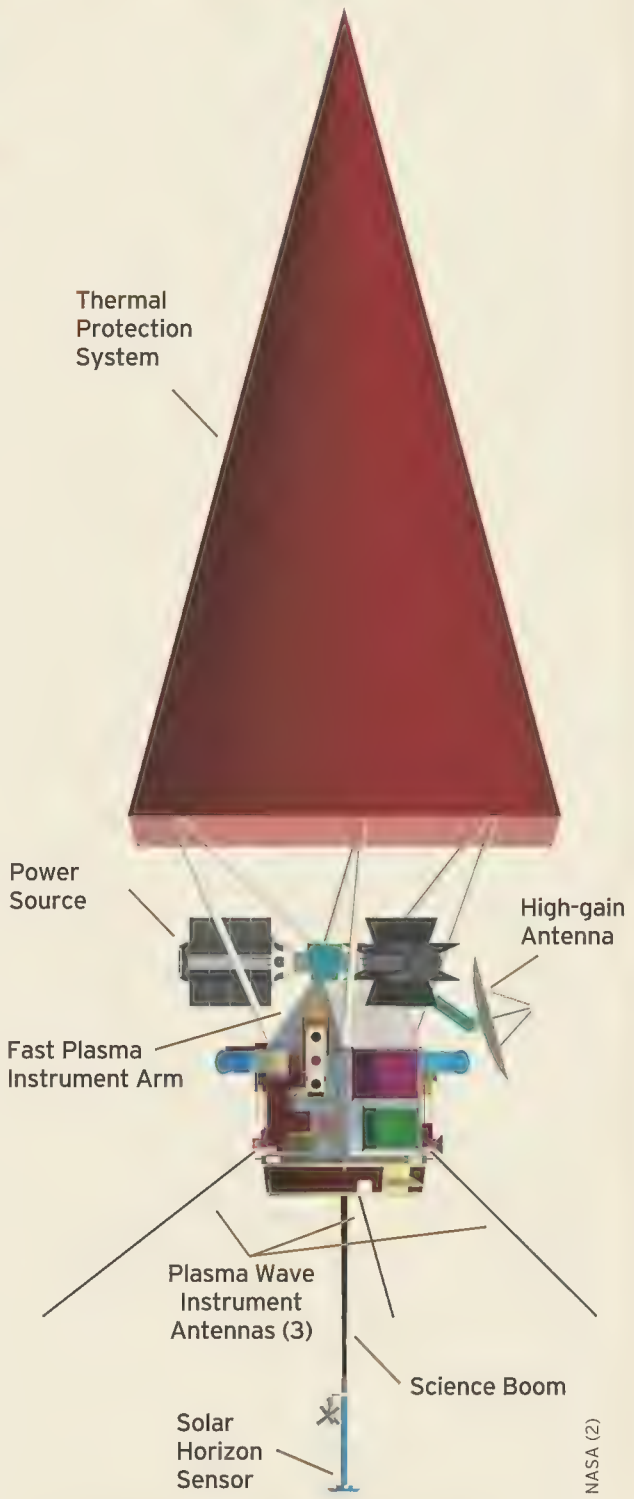
For the past decade, engineers have had the elements needed to build a probe that could withstand such an extreme environment, but the hard engineering specifics were solved only recently at the Applied Physics Laboratory, which is designing the spacecraft. "The thermal environment is the bugaboo," says McNutt. "Solar arrays melt at that distance." Spacecraft designers must find another power source without using costly plutonium batteries. One option is to use retractable solar arrays, which would likely be continually unfurled and retracted throughout the mission on multiple close approaches to the sun.

The most probable flight trajectory will use multiple flybys of Venus to gravitationally enable the spacecraft to lose enough rotational energy to make increasingly closer approaches to the solar corona. The first approach would occur about six months after launch. "With four close passes per year in the final orbit, an extended mission of even just two years would give us over 10 close flybys," says Dave McComas, a space physicist at the Southwest Research Institute in San Antonio and chairman of the science and technology definition team.

The instrument package is expected to include an optical imager, and if that makes the final design cut, the resulting photographs would show the surface of the sun with a clarity unachievable from Earth. "These images would be on the evening news," says McNutt. But he cautions that each instrument's scientific value has to be weighed against the total mission budget. "Are pictures [worth] a quarter of a billion dollars?"

The team has already trimmed its initial cost projections from $1 billion in its 2005 incarnation to a target cap of $750 million. Last July, the Senate Appropriations Committee earmarked $20 million for fiscal year 2008 to fund design tweaks and development for the probe. Part of the craft's high cost stems from the extensive ground-based tests, McNutt notes, designed to simulate the solar system's most extreme thermal environment.

The team presented its research to NASA last February. "We've been able to prove that [the solar probe mission is viable]," said McComas. "Now there's no excuse. It just needs to be done."



The probe's carbon heat shield must withstand temperatures of at least 3,140 degrees Fahrenheit, hot enough to turn it into a glowing red mass.

FIND OUT MORE TO LEARN ABOUT THE NEW IMAX MOVIE *3D SUN*, VISIT www.airspacemag.com.

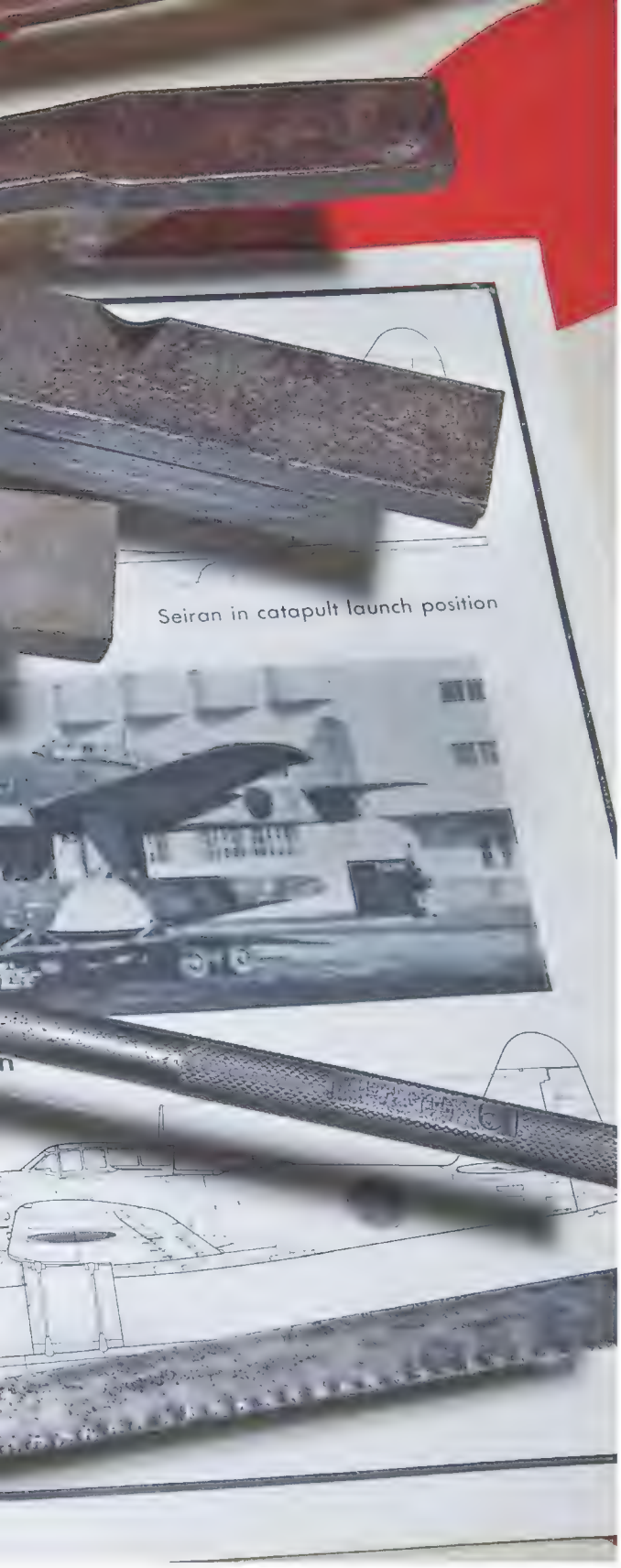
STOWAWAYS

THE STRANGE THINGS RESTORERS FIND IN OLD AIRCRAFT.

BY BETTINA H. CHAVANNE • PHOTOGRAPHS BY ERIC LONG

OVER THE LAST half-century, the Paul E. Garber Preservation, Restoration and Storage Facility in Suitland, Maryland, has restored some of the rarest and most important aircraft in history: a Northrop Flying Wing, the B-29 that bombed Hiroshima, a World War I-era Nieuport 28C fighter. The Garber complex has played as crucial a role in preserving aerospace history as its spiffier counterparts, the National Air and Space Museum on the Washington, D.C. Mall and the Steven F. Udvar-Hazy Center in Virginia. But in some ways, Garber is also like the Land of the Misfit Toys. Dark, dusty hangars house broken, battered pieces of equipment and aircraft waiting—often for years—for their moment to be brought back to life.

When the time comes, each aircraft is hauled out and taken apart, often down to the tiniest screw, and that is how the



restoration team ends up discovering stowaways—unexpected objects hidden in nooks and crannies, sometimes dating back to the earliest days of the aircraft.

Depending on their relationship to the aircraft that hosted them, these accidental artifacts fall into three general categories.

Details That Tell the Tale

Sometimes the Garber restorers come across objects that help flesh out the story of the aircraft, much the way little details make a scene in a novel easier to picture. Museum Specialist Bob McLean came across such an artifact while helping to restore the Lockheed Vega *Winnie Mae*, renowned as the aircraft in which Wiley Post made the first two solo flights around the globe, in 1931 and 1933. The airplane had been donated to the Smithsonian in 1936, a year after Post had died. While in the cockpit, McLean stumbled on an oil-soaked scrap of paper. "At first I thought it was just a receipt," he says. "But if you look closely, you can make out [numbers signifying] winds aloft and stations out west." So far, it's not known whether the handwriting is indeed Post's.

In the case of the Museum's Martin B-26 Marauder, *Flak Bait*, the Garber restorers unearthed artifacts in it that serve as reminders of the bomber's unusually violent career.

Flak Bait survived a formidable 207 missions over Europe, more than any other U.S. aircraft during World War II. And it has more than 1,000 patched flak holes to show for it. But though it could take plenty of punishment from the Germans, it was intolerant of abuse from its own pilots. "It was considered a very dangerous aircraft to fly because it was so unforgiving," says Museum Specialist Matt Nazzaro. "It had very high wing loading and was very fast for a medium bomber. Any pilot who commanded one would swear by the airplane, but if you made one critical mistake, there was no forgiveness."

In the course of surveying *Flak Bait*, the Garber restorers uncovered several paper clock faces pasted on the bulkheads. Nazzaro believes these were used to orient crew members when they spotted an enemy aircraft. "If they were disoriented, they could just look at the clock and properly communicate where the enemy was: 'Bandit at two o'clock,' for example."

When the restorers removed the rear fuselage cabin floor, they discovered four .50-caliber shell casings, marked with a 1942 manufacturing date. Nazzaro believes the bullets were fired "probably from the waist guns" of the bomber.

Flak Bait's entire floor was covered with 10-millimeter-thick armor plating. "It was like a high-grade-steel throw rug," says Nazzaro. "It slowed down the airplane because it was so heavy, but it was necessary to prevent flak from coming up through the floor and killing people." When they pulled up the armor plating, Nazzaro says, the restorers found "mud from airfields 50 years back under there."

They also saw wooden matches strewn everywhere, as well as automobile ashtrays riveted to the interior. "These guys were smoking their brains out," Nazzaro says. "After a dangerous mission like the ones they flew, wouldn't you?"

Probing the interior of a Japanese Seiran bomber, National Air and Space Museum restorers found all sorts of scraps revealing the state of Japan in World War II (above). Below: Two .50-caliber shells recovered from the belly of a B-26 with a violent past.

INSIDE THE OLD GLIDER, THE RESTORERS FOUND A DELICATELY EMBROIDERED HANDKERCHIEF. HAD IT BEEN GIVEN TO THE PILOT BY A BELOVED FAMILY MEMBER, OR BY THE OBJECT OF HIS AFFECTIONS? AT SOME POINT, HAD A WOMAN FLOWN THE GLIDER? IT'S FUN TO IMAGINE THE POSSIBILITIES.

Restorers Bob McLean (left) and Matt Nazzaro are often the ones who discover the Museum's unofficial artifacts.

Details That Set the Stage

Some of the stowaways uncovered at Garber illuminate not the history of the individual aircraft but rather the time and place in which it served. Last July, intern Eric Lawrence was cleaning out a Curtiss F9C-2 Sparrowhawk, a small, airship-based fighter that the Navy used in the 1930s for reconnaissance patrols along the U.S. coasts. When he was working in the fuselage tail cone, Lawrence came across a broken pencil, inscribed with the words "Hoover for President, 1928."

Evocative items seemed to pour out of the sole surviving Japanese Aichi M6A1 Seiran, a World War II bomber designed to be stashed in a submarine, its wings folded, until the sub surfaced for launch. Allied forces discovered a Seiran at the Fukuyama training base after World War II and brought it to California on a U.S. carrier. It was eventually donated to the Smithsonian.

The restoration "was an unusually long project," says Nazzaro, lasting from 1989 to 2000. "It's probably the most accurately restored and one of the finest restorations of any Japanese World War II aircraft in the world. You get inside that airplane and you go right back to 1945."

During the process of removing, cleaning, and cataloging every bolt and rivet in the Seiran, a number of items turned up. "We scraped up the dirt in the bilge, filtered and cleaned it, and found these artifacts," says Nazzaro, holding up several tools and plastic bags filled with metal scraps. One of the tools is a hand-made bucking bar, which is placed on the other side of a piece of metal being riveted in order to dampen the shock of the rivet

While the Seiran stowaways likely came from workers who'd assembled the aircraft, the artifacts unearthed from the 1930s Bowlus Albatross glider – a delicate handkerchief, a brass-capped pencil – appear to have been left by those who flew the craft.

The gum wrapper is modern, but the medallion, scraps of paper, and builder's plate (with the aircraft's serial number) go back to the Hawker Hurricane's years of operation in World War II. Right: This scrap could document a history-making flight by Wiley Post.

gun. "You can see an actual finger notch here," says Nazzaro, gripping the Seiran tool to show how fingers fit the bucking bar. "It was probably made for a small hand, maybe a woman or a student. That tells a story for me."

The metal scraps the restorers found in the Seiran are small and round and have sharp edges. "Someone probably realized he needed a hole drilled through a bulkhead but didn't have a hole saw," Nazzaro says. "He used a standard drill instead, and drilled 50 or so holes close together and then knocked it out. He didn't even bother to smooth the edges so it wouldn't cut whatever wires were passing through here. An American airplane would have had a rubber grommet around that hole."

In an inboard-wing fuel tank, restorers found inspection progress records, a worker time card, and a warehouse receipt.

Nazzaro believes the artifacts in the Seiran provide clues to the mood prevailing in wartime Japan. The material the restorers discovered, he says, shows "their urgency, how really desperate they were to get this flying. It speaks to the level of quality in their factories."

Mysteries remain. One of the forms had a handwritten note on it, which translates to "Yesterday's thought. Today's thought. There is no difference." Is that a sign of dedication and focus, or of demoralizing boredom?

Details That Don't Fit

And then there are the finds that no one can account for.

Beneath the pilot's seat of an elderly glider, a Bowlus 1-S-2100 Senior Albatross built in 1933, restorers found a linen handkerchief, delicately embroidered with flowers. Says Bob McLean: "It looks like something a wealthy person would have carried with them—but that's just my impression."

The American-made Albatross, named *Falcon*, had been donated to the Smithsonian in 1935 by the widow of Warren E. Eaton, who had flown SPAD XIII fighters in the 103rd Aero Squadron in France during World War I. After the war, Eaton founded the Soaring Society of America. Could the embroidered handkerchief have been given to him by a beloved family member, or by the object of his affections? At some point had a woman flown the glider? It's fun to imagine the possibilities.

A small medallion—discovered tightly crumpled around a screw in a World War II British Hawker Hurricane Mk.IIC fighter—also ended up teasing the restorers with possible storylines. Museum Specialist Will Lee, who found the medal while working on the Hawker restoration, took the time to straighten it out, make it recognizable, and do some investigating. "It's actually a watch fob," says Lee. In the course of researching the item, Lee learned the meaning of the medallion's icons: "The anchor symbol means it was made in Birmingham, England. The lion indicates that it's made of silver, and the letter corresponds to a date—in this case, 1915." But who had owned the medallion? A pilot? A maintainer? A person of wealth? And why was it wrapped around a screw?

Whoever the medallion's owner was, he may have had a sweet tooth: While working on the Hurricane, Garber employees also found a vintage candy bar wrapper.

THE HANDKERCHIEF from the Albatross and the pencil from the Sparrowhawk were both catalogued and attached to the aircraft's collections by their curators. Not all items discovered during the restoration process are classified this way. "It really depends on the mood of the curator," says McLean, "whether he has time to process the item and whether he even knows about it."

No matter what object the restorers find, even when they can't fit it into any kind of narrative, they take it seriously. They know that what looks like a piece of junk can be brought to life by the right insight. At Garber, a jagged metal scrap can serve as a small portrait of wartime desperation, and a dirty list of scribbled numbers can show the drive it takes to set a world record—twice.

I MADE MY FIRST TRIP TO JAPAN shortly after my first trip to space, on the shuttle *Endeavour*, in 1996. The main job on that mission had been to retrieve the Space Flyer Unit, a Japanese satellite launched months earlier as a platform to test materials and conduct experiments in orbit. After we returned the satellite to Earth, our six-man crew went on a post-flight tour of Japan, visiting schools, civic groups, and the factories where components of the satellite had been manufactured.

Despite my longstanding interest in Japanese culture, I was unprepared for the warmth and adulation that greeted our shuttle crew. At one school we stepped out of our cars to see a line of 200 children, each holding a bouquet of flowers. In synchrony they rushed up and surrounded us in a gigantic floral arrangement, calling out our names and singing songs as they showered us with the bouquets. I still have some of those flowers.

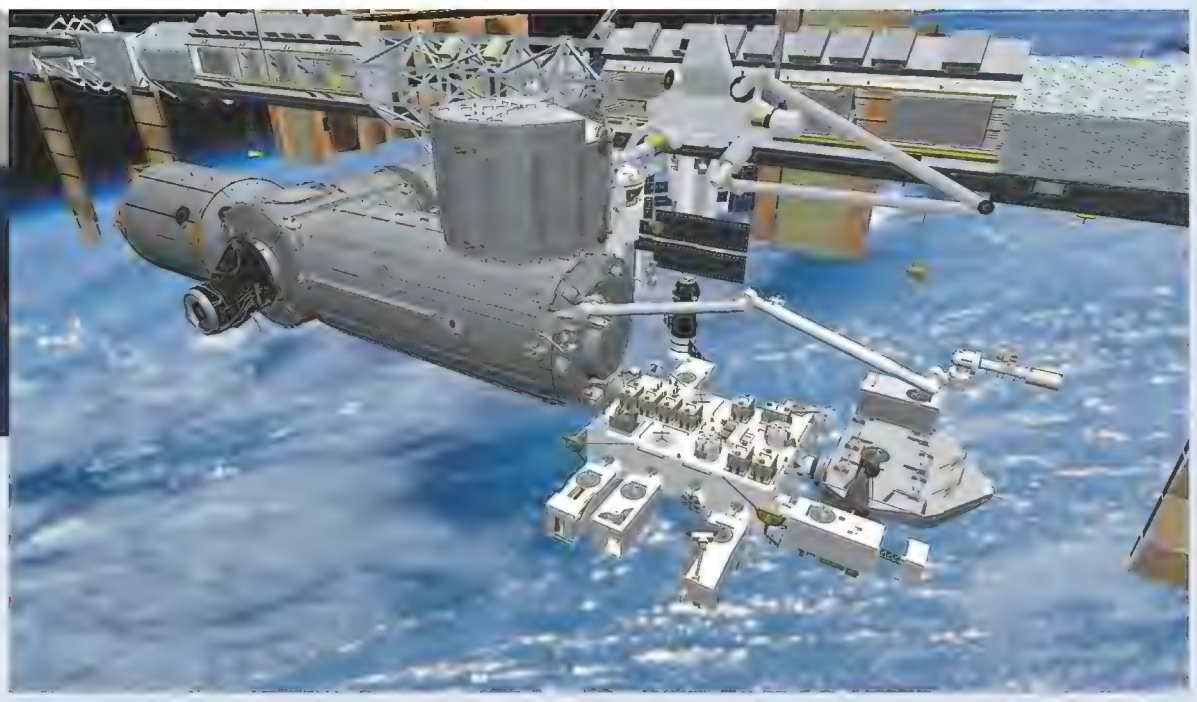
If we NASA astronauts were treated as honored guests, our Japanese crewmate, Koichi Wakata, was a rock star. One evening in Tokyo, we were walking back to our hotel from an embassy party when a group of teenage girls walked by in the other direction. They continued for another 40 feet or so, then turned around and ran back to us, screaming, "Wakata-san, Wakata-san!" When they reached us, they began jumping up and down, screaming and flapping their arms rapidly. We saw this behavior by young girls again and again around Koichi, so often we came to expect the dance and gave it a name: the Penguin.

I've returned to Japan several times since, and in some ways, the country feels to me like the America of the 1950s. At gas stations, attendants surround your car, filling it up, washing windshields, and checking the tires. There are greeters in department stores and someone to push the button for you on the elevator. The taxis are so clean that the drivers wear cloth gloves and the seats are covered in white lace linen. People leave their hand-

Konnichi Wa, Kibo

THE INTERNATIONAL SPACE STATION SAYS HELLO TO ITS NEWEST ADDITION, MADE IN JAPAN.

BY DAN BARRY



Three to get ready: Astronauts (from left) Satoshi Furukawa, Akihiko Hoshide, and Naoko Yamazaki train for duty on the space station (depicted at right, with Kibo and its porch-like exposed facility attached).

LEFT: NASA; RIGHT: JAXA

bags on the counter when using a public restroom. In Tokyo you can walk safely almost anywhere late at night.

And, like the United States in the 1950s, Japan is embarking on an expensive, long-term program of human space exploration. More than 20 years after joining the International Space Station partnership, the country will finally see a return on its investment when its Kibo ("Hope") laboratory is installed as the station's last and largest module, alongside NASA's Destiny, Russia's Zvezda, and Europe's newly arrived Columbus.

Kibo has most everything you'd want in a space laboratory. Its 37-foot-long pressurized module affords plenty of volume for astronauts to conduct research. An exposed facility attaches like a porch to the outside of Kibo so that some experiments can be exposed to the vacuum of space. There's a separate storage module, and a Japanese-built robot arm, or remote manipulator system, to move equipment from one location to another. A final Japanese contribution, called the H-II Transfer Vehicle, is a rocket-borne cargo container that can deliver supplies or research equipment to the station. The cargo vehicle is scheduled to be launched from the

Tanegashima Space Center in southern Japan next year.

During the two decades in which the Japanese have been designing and building this hardware, they have also been assembling a modest astronaut corps. Today there are eight Japanese astronauts, five of whom have already flown on NASA's space shuttle. All have science or technology backgrounds; none came from the world of military aviation.

Takao Doi, a shuttle veteran and one of the first three Japanese astronauts chosen in 1985, will operate the station's robot arm to install Kibo's first piece, the storage module, on the space station this spring (the pressurized module will go up on the shuttle after that, and the exposed facility will be delivered several flights later). Wakata, who has flown in space twice, will be the station's first long-term resident from Japan, arriving this October for a five-month stay.

Japan's first shuttle astronaut was Mamoru Mohri, a materials scientist who flew twice in space and now, at 60, runs the Miraikan science museum in Tokyo. Along with Doi and Chiaki Mukai (who in 1998 was on the same crew with John Glenn during the latter's celebrated return to space), Mohri reported to Houston for training in late 1985. He remembers the culture shock. "Before I went to the Johnson Space Center, I didn't realize there were so many astronauts training," he says. "At that time there were about 150. Every three months a space shuttle was being launched."

Mohri is the most famous of Japan's small band of astronauts,

Mamoru Mohri (below, at right) was Japan's first space shuttle astronaut. Koichi Wakata (at left) has flown twice. When he arrives later this year for a five-month stay, Wakata will become the first long-term Japanese resident on the space station.

NASA

and he appears on Japanese television frequently as a spokesman for space exploration. "For a long time [after his 1992 shuttle mission], I was the only one who had flown," he says. While the news media pay close attention when a Japanese astronaut flies (the most recent was Soichi Noguchi, a former aeronautical engineer who was on the first post-*Columbia* shuttle mission, in 2005), human spaceflight hasn't gotten the headlines lately that other Japanese space accomplishments have, such as the Hayabusa probe's visit to asteroid Itokawa in 2005, and the high-definition TV images that the Kaguya orbiter recently began beaming back from the moon. The launch of Kibo promises higher visibility for Japan's astronauts, who will now spend months at a time working in orbit inside a Japanese-built module.

For Europe and Japan, the project's junior partners, building the space station has been an exercise in patience. U.S. budget politics and shuttle delays have led to design changes and to shifts in the plans NASA has for its own use of the station. Meanwhile, Japan and Europe have stayed on their original course. The Japanese Aerospace Exploration Agency (JAXA) will launch much the same hardware that its predecessor, the National Space Development Agency of Japan, envisioned in the 1980s. And the list of experiments that Japanese university researchers proposed years ago—some of them follow-ups to Japanese studies conducted on 1990s shuttle/Spacelab missions—has for the most part remained fixed.

"NASA has changed its goal to technology development for

JAXA (2)

The Kibo pressurized module under construction in December 2006 (left), and October 2007 (below). The 14.4-foot-diameter laboratory is the station's largest. Inside, the module will be outfitted with racks of experiments.

and art are under consideration too, says Kamigaichi.

JAXA has invited other Asian nations to propose experiments on Kibo, and has held conferences to solicit ideas from researchers in Vietnam, Thailand, Malaysia, Indonesia, and other nations. While these would likely be modest student experiments, South Korea (which is sending an astronaut to the space station this spring) has expressed interest in building a substantial piece of experimental hardware, says Kamigaichi. Such joint ventures could establish Kibo as the Asian—not just the Japanese—sector of the space station.

AFTER MY SECOND SHUTTLE FLIGHT, in 1999, I lived and worked in Japan as the NASA astronaut office's liaison to the Japanese space agency. I was in Tsukuba, a "science city" full of elevated walkways lined with trees and flowers, and it was there that I was introduced to Japanese engineering culture.

On my very first day, I attended a meeting where I learned about Japanese courtesy. I was the only one in the room who didn't speak Japanese, but the entire meeting was conducted in English for my benefit. Even the slides had been translated. I tried to imagine NASA holding a meeting in Japanese because one visitor didn't speak English. Inconceivable. After a week of such special treatment, I resolved to learn enough Japanese to understand the technical talks, despite having always been "language challenged."

At first I was frustrated by the enormous amount of time the Japanese devoted to setting the tone for a meeting or a test. Everyone had to be present and in just the right spot; everyone had to hear the initial briefing, even when (I thought) everyone already knew the material. For every test, there were always at least two video recorders running (somewhere at JAXA there must be a ski slope made of thousands of used video tapes). After a while, though, I came to appreciate that all the preparation made the tests run very smoothly. We never had to wait for someone who was running late. There was never a missing tool. The test equipment always worked correctly the first time.

[moon-Mars] exploration," says Shigeki Kamigaichi, who manages JAXA's space station utilization program. "But in Japan, our goals still involve basic science," including investigations into crystal growth, fluid physics, cell and plant biology, and the effects of space radiation on various life-forms, including humans.

Kibo brings several unique capabilities to the station, starting with the porch-like facility. The Japanese robot arm will be used to transfer experiments through an airlock so that researchers studying the behavior of materials in space will have a "hard vacuum." Another facility, an aquatic habitat, is proposed for the second phase of Kibo research, to begin after 2010. The aquarium will allow multi-generational studies of species, including zebrafish, a remarkable creature commonly used in developmental biology and genetics experiments because its embryo is transparent, a trait that makes it easier to observe the secrets of cell division and distribution.

Japan will share the Kibo facilities with its international partners. Japanese astronauts will use them only half of the time. Of that allocation, Kamigaichi says a "small portion" will be set aside for non-traditional pursuits, including cultural activities that JAXA created as a way for the Japanese public to contemplate life and the universe. In the "Space Poem Chain," nationally known poets are selecting entries from a competition, and a DVD with the first 24 winning poems will be carried up with Kibo when it is installed. Projects in space dance

Bill Jordan worked in Japan from 2000 to 2007, first as the NASA representative to Japan's space agency, then as the NASA attaché at the U.S. embassy in Tokyo. When working with Japanese engineers, he says, " 'Yes' doesn't always mean yes." He recalls one meeting in which NASA representatives presented a concept for a latching mechanism. "We looked to the Japanese for concurrence and thought we had it," he says. "But sometimes a positive acknowledgment is an indication of 'I understood what you said,' not 'I agree with you.' The next day, the Japanese side presented a completely different design, disregarding everything we had discussed the day before." It took several more meetings to settle the differences.

Japanese culture highly values appearance and presentation. Meals often arrive in elegant and creative arrangements on the plate. Reflecting the attention to appearance, Japanese workplaces are exceptionally clean and well organized. Jennifer Goldsmith, a member of NASA's Vehicle Integration Test Team, spent several years in Japan developing space station hardware. She recalls one incident in which her more casual American attitude came into sharp focus. By NASA tradition, any modules built to house astronauts in space are subject to final alterations based on "crew preference," which aren't likely to show up in formal requirements documents. "Once the Kibo hardware arrived in the United States," Goldsmith recalls, "I started to [mark] crew preference [changes] on the JAXA hardware with a Sharpie marker. To see the Japanese technicians' eyes widen at the sight of me writing on their beautiful flight hardware was amazing."

There are institutional differences as well. Unlike NASA, JAXA is not an independent government agency. Its funding comes from the Ministry of Education, Culture, Sports, Science and Technology, but its employees are not civil servants, and there are fewer safeguards against a "revolving door" tradition of employees moving back and forth between government and industry. The relationships between industry contractors and government overseers can be puzzling to Americans. I learned this first-hand, when Kibo's pressurized module was about to be shipped from the Mitsubishi factory in Nagoya, where it was built, to the NASDA space center in Tsukuba in 2001.

Japanese quality inspections conducted during the final phases of manufacturing sometimes have the tone of a religious ritual. Top company executives are on hand along with the engineers and technicians, and attendance by outsiders is strictly controlled. The Mitsubishi representatives suggested that I watch the inspection on a TV monitor in a remote office. I was stunned—had I traveled from Houston to Nagoya just to watch a ceremony on TV? This was supposed to be a real test, not a formality, and it was the last chance to raise concerns about the module before Kibo's hatch was closed and ownership was transferred from the manufacturer to the Japanese space agency. When I pointed out that NASA was required to verify that every bolt and fixture inside the module fit the standard astronaut tools on the space station, I was reluctantly allowed to participate as "Test Subject 2."

"Test Subject 1," I was surprised to learn, was an employee of Mitsubishi, not NASDA. His job was to go through the entire module, methodically fitting tools to every fixture—all under the watchful eye of his boss' boss' boss. Imagine the pressure he felt. One misfit would ruin the ceremony.

The inspection began with each person taking a place around a circle, each place marked with footprints. The hierarchy was crystal-clear. Non-participants stood behind the circle. A reader called out the first fixture and the tool to be used. One guide showed us the fixture as another guide pulled the proper tool out of the box and carefully handed it to Test Subject 1. He fit the tool on the fixture, then handed it to me so I could do the same. We both stated that the tool fit, and the concordance was duly marked by the recorder.

Over the course of many hours, Test Subject 1 and I tried every single bolt, nut, and fixture in the module. The vast majority were absolutely fine, better than most space hardware I have inspected. But every once in a while, Test Subject 1 would fit a tool and hand it to me, and I would have trouble making it fit. The offending fixture was duly noted and marked for repair. In the end, everyone agreed the test was a resounding success.

When I returned to Tsukuba, I asked about the policy of allowing contractors to do their own inspections, and was assured that space agency personnel would conduct a complete inspection once the module arrived at the research center. Of course, repairs would be more troublesome at that point than when Kibo was still at the factory, but to do otherwise could insult

Whenever a Japanese astronaut has flown, public interest has been high. Here citizens of Soichi Noguchi's hometown, Chigasaki, celebrate his July 2005 launch on *Discovery*.

NASA (2)

Takao Doi's inspirational message floats in *Columbia*'s cockpit during his 1997 shuttle flight. Doi will be working the shuttle's robot arm to attach Kibo's first element to the station.

the contractor. As for me, at least I had made things less tense. The Japanese could consider the flaws that I found just overzealous pickiness by the NASA guy. And, even though repairing them really was required, it could be construed as a favor, not a reflection of deficient manufacturing.

None of this is meant as a criticism of Japanese space engineering. In fact, JAXA and its predecessor agencies have a solid record of successes, going back to the 1970s, in launching spacecraft for astronomy, solar physics, and Earth observation. But the switch from building satellites to building hardware for human spaceflight, with its more stringent safety requirements and need for tight coordination, is difficult for any nation, including the United States and Russia, which, nearly 50 years after their first spaceflights, still make the occasional mistake. And Japan has proven no exception.

AP PHOTO/SHIZUO KAMBAYASHI

My own shuttle mission, STS-72, offered a small example. While the Space Flyer Unit was a remarkable satellite and ultimately a success, it did have glitches. The first hint of trouble came when its solar arrays jammed while retracting. We had to jettison them, which took valuable time; the satellite could last only about an hour on battery power after the arrays were shut down. Without power, the onboard heaters would fail, causing the satellite's propellant lines to freeze and rupture. We couldn't bring a propellant-spilling satellite into the shuttle's bay; we'd have to abandon it.

Koichi Wakata had the job of using the shuttle's robot arm to bring the spacecraft into the cargo bay. All was going well until the last step, when the satellite wouldn't engage the locking latches. We could get two or three to lock, but not the required four. As he tried over and over, Koichi was the picture of cool concentration—no panic in that guy. But time was running out. Finally, with just five minutes of battery life remaining, he turned to us and said, "Here goes a slam dunk; be ready with those latches!" He revved up the arm and brought the satellite down like Karl Malone going to the basket. Sure enough, four latch lights lit, and we returned the satellite safely to Earth.

What had gone wrong? We never found out for sure. Most likely, a combination of weightlessness and exposure to the hot-cold cycles of space had slightly warped the satellite frame. We were lucky the warping was within the margins of what the latches could accommodate. It was another lesson in the complexities of space hardware, which—especially on large projects—often has to fit parts fabricated in different places at different times.

Nowhere is this more true than on the space station, the largest orbital construction project in history. The station's pieces were built in multiple countries, and the assembly will take more than a decade. New modules like Kibo and Europe's

Columbus have to attach to U.S. and Russian modules that have been in space for years. To complicate things more, the station is pressurized, and adding or removing air can change the shape and stiffness of the modules, which have a hull thickness of just 1/16 of an inch. All of these factors raise the same concerns about hardware compatibility we had experienced with Japan's Space Flyer Unit.

Japan finds itself playing a different role than it did on past shuttle flights. Even when the science experiments were Japanese, the vehicle—and the overall mission responsibility—were NASA's. Now, as a full partner in the station program, JAXA will control Kibo from the Tsukuba Space Center in Japan, just as NASA controls its segment from Houston, Russia controls its segment from Moscow, and Europe runs the Columbus module from outside Munich. With the lives of astronauts at stake, decisions will have to be made jointly, but quickly and efficiently. On the first Japanese assembly flight, Mayumi Matsuura will be in Tsukuba as the lead flight director for Kibo. "This is the first time for us to deal with minute-by-minute operations on a daily basis," she says.

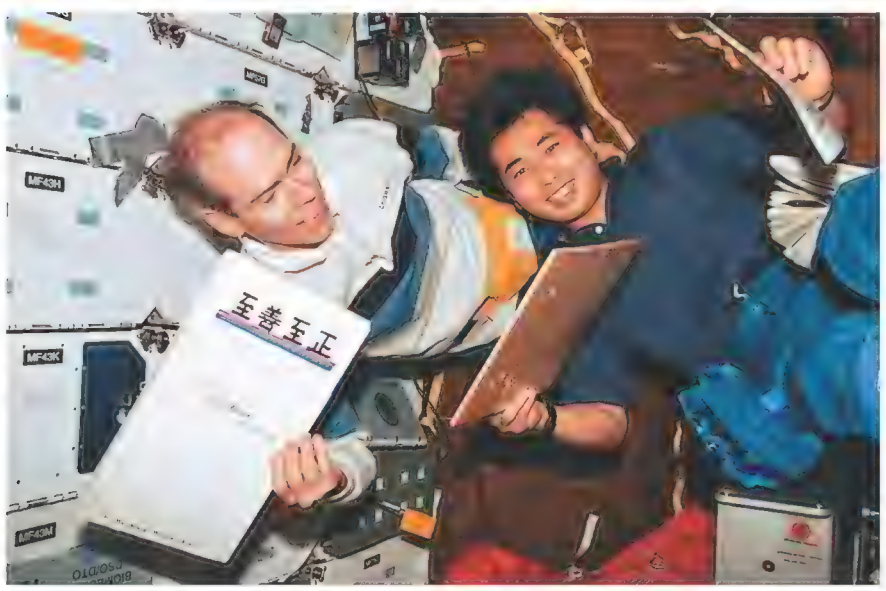
To prepare for these duties, JAXA flight controllers have been participating in simulations with their international counterparts, learning how to make routine decisions and handle emergencies. Things don't always go smoothly, according to Mohri, who has been involved in some sessions. "Compared to NASA, JAXA is immature still," he says. When Japanese controllers fail in these simulations, it can be awkward, he admits. Still, every spacefaring nation has had to walk the same road. "Always we are learning," says Kamigaichi, who is confident any problems will be worked out.

The learning curve extends to training astronauts on the ground, which has its own risks. I know that from direct experience. Several years ago I had an opportunity to try out a new Japanese underwater tank built by JAXA for spacewalk training. The pool is similar to the one used to train astronauts at NASA's Johnson Space Center in Houston, but is smaller and designed specifically to accommodate Kibo.

During one run to evaluate the setup of Kibo's pressurized module and the placement of outside payloads, I was methodically moving along the border of the exposed facility when I felt a sudden depressurization of my spacesuit, followed by the feeling of water pressure squeezing my legs like giant blood pressure cuffs. I sank so fast that my two safety divers were unable to catch me. Within seconds I was at the bottom of the 34-foot-deep pool. Water pressure was now pushing my soft body up into the hard parts of the suit and helmet. That put severe pressure on my diaphragm, causing pain and making it very difficult to breathe.

NASA

Noguchi takes questions after his 2005 shuttle flight. Below: On board *Endeavour* in 1996, the author (at left) and crewmate Koichi Wakata played the first game of Go in space.



NASA

Suddenly I was surrounded: A flurry of cameramen and utility divers joined the safety divers to lift me from the bottom. It seemed to me to take only five or 10 seconds, but later review showed I was at the bottom for a minute and a half.

As it turned out, a technician had mistakenly turned a valve that allowed the suit to depressurize. He came to me the next day and apologized profusely. I assured him that no harm was done and that in the world of spaceflight, training accidents are part of the risk we accept. But I remember thinking that this was the sort of accident that occurs early in the life of a facility. NASA's underwater tank has occasional hardware failures, but there are very few procedural errors. The hard lessons were learned years ago.

Mohri says that although the Japanese public approves of space exploration, if the government is to continue funding space ventures, Kibo must produce "clear results" to show that the roughly $9 billion invested in the space station was not wasted. Those results could come in the form of scientific progress. Mohri, though, sees another, perhaps more important, benefit coming from the country's space station participation. He views Kibo as a kind of political laboratory, where the four major partners—the United States, Russia, Europe, and Japan—have to learn to compete and cooperate at the same time. Each will pursue its own goals, but in an emergency, they'll have to pull together and make decisions for the common good. "If something wrong happens inside Kibo, then four ground stations have to talk about whether we abandon the module or not, and how they can help," he says.

Mohri has been preaching the value of the space station as "a case study of how we can work together to save Earth." If the idea catches on, then perhaps Japan, the partner whose learning curve has arguably been the steepest, will have discovered the project's true purpose.

COME AND SEE THE SHOW SUMMER 2008

It's Show Time!

AVIATION FANS will have more airshows to watch than presidential debates this year, with almost 200 shows across the country between April and November. And those fans who attend will be continuing a tradition that started in Reims, France, 99 years ago with the first international air meet. In 1910, the Wright brothers got into the act, forming a team to show off their flying machines (p. 48). Within a decade, a whole new type of air circus star stepped out onto an airplane wing and began one of aviation's most daring professions (p. 42). Airshow teams and wingwalkers are still entertaining thousands today. *So carry on the tradition: Come and see the show!*

Air & Space/Smithsonian 2008 U.S. Airshow Schedule

ALABAMA

Albertville Apr. 26
Albertville Airshow

Birmingham Sept. 19 & 20
Wings & Wheels

Huntsville June 28 & 29
Huntsville International Airport Airshow (Blue Angels)

ALASKA

Eielson AFB June 24
Eielson AFB Airshow (Thunderbirds)

Elmendorf AFB June 28 & 29
Arctic Thunder (Thunderbirds)

ARIZONA

Douglas Oct. 1
Douglas Airshow (Snowbirds)

Kingman Oct. 11
Kingman Air and Auto Show

Prescott Oct. 4
Arizona Skyfest

ARKANSAS

Fort Smith May 17 & 18
Fort Smith Regional Airshow (Thunderbirds)

Little Rock AFB Oct. 18 & 19
(Blue Angels)

CALIFORNIA

Camarillo Aug. 16 & 17
Camarillo Airshow

Chico Sept. 26 & 27
Chico Airfest (Snowbirds)

Chino May 17 & 18
Planes of Fame

Fresno June 13 & 14
KJWL Father's Day Airshow and Fly-In

Hemet July 19
Hemet Ryan Airshow

Huntington Beach Oct. 18 & 19
Huntington Beach Air & Water show

Long Beach Aug. 23 & 24
Wings Over Long Beach

Los Angeles July 12
American Heroes

March ARB May 3 & 4
March ARB Airshow (Thunderbirds)

Marysville June 6-8
Golden West EAA Regional Fly-In and Airshow

Modesto May 10
Modesto Airport Appreciation Day

Porterville June 21
Eagle Mt. Airshow

Redding Oct. 4 & 5
Redding Airshow

Riverside Oct. 18
Neighborhood Leaders to National Heroes

Salinas Sept. 27 & 28
California International Airshow (Thunderbirds)

San Carlos June 20 & 21
Vertical Challenge Helicopter Airshow

San Diego Oct. 3-5
MCAS Miramar Airshow (Blue Angels)

AT-6s/AEROSHELL AEROBATIC TEAM: ARNOLD GREENWELL

COME AND SEE THE SHOW SUMMER 2008

CALIFORNIA *(CONT.)*

San Francisco Oct. 11 & 12
San Francisco Fleet Week
(Blue Angels, Snowbirds)

Santa Maria Aug. 22-24
Thunder Over the Valley

Santa Rosa Aug. 16 & 17
Wings Over Wine Country

Shafter Apr. 19
Warbirds in Action

South Lake Tahoe June 28
Lake in the Sky Airshow

Thermal Nov. 1
Jacqueline Cochran Airshow

Travis AFB Aug. 30 & 31
Travis Air Expo (Thunderbirds)

Watsonville May 23-25
Watsonville Fly-In & Airshow

COLORADO

Akron Sept. 6
National Radial Engine Exhibition

Denver June 27-29
Front Range Airshow

Grand Junction Sept. 27 & 28
Grand Junction Airshow (Blue Angels)

Pueblo July 4-6
In Their Honor Airshow

Rifle Aug. 8 & 9
Garfield County Air Fair

CONNECTICUT

Bradley ANGB July 19
Bradley Space & Aviation Day

DELAWARE

Dover AFB Sept. 20 & 21
Dover AFB Open House

FLORIDA

Gainesville May 10
American Heroes

NASA Kennedy Space Center
Nov. 8 & 9
Air-Space Expo (Blue Angels)

Lakeland Apr. 8-13
Sun 'n' Fun (Thunderbirds)

MacDill AFB May 3 & 4
MacDill AFB Airfest

NAS Jacksonville Oct. 25 & 26
NAS Jacksonville Airshow
(Blue Angels)

NAS Pensacola Nov. 15 & 16
Blue Angels Homecoming
(Blue Angels)

Pensacola Beach July 11
Pensacola Beach Airshow
(Blue Angels)

Punta Gorda Apr. 5 & 6
Florida International Airshow
(Thunderbirds)

St. Petersburg Oct. 18 & 19
St. Petersburg Airfest

Stuart Nov. 7-10
VNA Airshow

GEORGIA

Atlanta May 17 & 18
American Heroes

Augusta Oct. 18 & 19
Boshears Skyfest

Dobbins ARB Oct. 18 & 19
Wings Over Marietta
(Thunderbirds)

Hinesville June 14-16
Midcoast Extravaganza

Rome Sept. 12-14
North Georgia Transportation
Expo

Vidalia Apr. 26 & 27
Vidalia Onion Festival Airshow
(Blue Angels)

Warner Robins AFB Oct. 18 & 19
Warner Robins AFB Airshow

IDAHO

Mountain Home AFB Sept. 13 & 14
Gunfighter Skies (Thunderbirds)

Rexburg June 14
Legacy Flight Museum Airshow

Twin Falls July 26 & 27
Air Magic Valley (Blue Angels)

ILLINOIS

Chicago Aug. 16 & 17
City of Chicago Air & Water Show
(Blue Angels)

Mattoon July 4
Coles County Airport Day

Peoria Apr. 19 & 20
Prairie Airshow (Blue Angels)

Rantoul June 6-8
Chanute Air Festival

Rockford June 7 & 8
Rockford Airfest (Thunderbirds)

Scott AFB Sept. 20 & 21
Scott Airshow (Thunderbirds)

Waukegan Sept. 6
Waukegan Regional Airshow

INDIANA

Evansville June 27-29
Evansville Freedom Festival

Gary July 19 & 20
South Shore Airshow

Greenfield Aug. 23 & 24
Indianapolis Airshow

IOWA

Davenport June 21 & 22
Quad City Airshow (Blue Angels)

Des Moines Aug. 8-10
Fly Iowa: Wings, Wheels & Water at
Storm Lake

Dubuque July 3
Dubuque Airshow & Fireworks

KANSAS

Wichita Aug. 22-24
Wichita Flight Festival

KENTUCKY

Louisville Apr. 12
Thunder Over Louisville

LOUISIANA

Barksdale AFB May 10 & 11
Defenders of Liberty Open House
(Blue Angels)

Lafayette Nov. 1 & 2
Sertoma Cajun Air Festival
(Thunderbirds)

Slidell Apr. 8
Slidell Open House

MAINE

NAS Brunswick Sept. 6 & 7
Great State of Maine Airshow
(Blue Angels)

MARYLAND

Andrews AFB May 17 & 18
DoD Joint Services Open House
(Blue Angels)

Frederick/Ft. Detrick May 17
American Heroes

Ocean City June 10 & 11
Ocean City Airshow

MASSACHUSETTS

Westover ARB Sept. 6 & 7
The Great New England Airshow
(Thunderbirds)

MICHIGAN

Alpena Aug. 23
Wings Over Alpena

Battle Creek July 4-6
Field of Flight Airshow & Balloon
Festival (Thunderbirds)

Detroit July 11-13
Detroit APBA Gold Cup

Traverse City July 5 & 6
National Cherry Festival Airshow
(Blue Angels)

Ypsilanti Aug. 9 & 10
Thunder Over Michigan

MINNESOTA

Duluth May 14
Duluth Air Show (Snowbirds)

Duluth July 19 & 20
Duluth Air & Aviation Expo
(Blue Angels)

MISSISSIPPI

Greenville Sept. 13 & 14
Delta Air & Balloon Festival

Jackson Apr. 26
Hawkins Field Airfest & Airshow

MISSOURI

Cape Girardeau July 5 & 6
Cape Girardeau Regional Air
Festival

Columbia May 24-26
20th Annual Salute to Veterans
Celebration

Kansas City Aug. 23 & 24
KC Aviation Expo (Thunderbirds)

Kirksville Sept. 13
Kirksville Airport Day

Springfield July 4
I Love America

MONTANA

Malmstrom AFB May 17 & 18
Malmstrom AFB Airshow
(Snowbirds)

NEBRASKA

Offutt AFB Aug. 16 & 17
Defenders of Freedom (Thunderbirds)

NEVADA

Nellis AFB Nov. 8 & 9
Aviation Nation (Thunderbirds)

Reno Sept. 10-14
National Championship Air Races
(Thunderbirds)

NEW JERSEY

Atlantic City Aug. 20
Thunder Over the Boardwalk
(Thunderbirds)

Camden Aug. 2
Battleship New Jersey Aviation
Awareness Day

McGuire AFB May 31 & June 1
McGuire AFB Open House &
Airshow (Thunderbirds)

NEW MEXICO

Farmington Sept. 13
Farmington Airshow

Santa Fe Sept. 20
Santa Fe Airshow

LOCKHEED C-5/NELLIS AIR FORCE BASE: CAROLINE SHEEN

BRITISH ARMY PARACHUTE REGIMENT FREEFALL TEAM: ARNOLD GREENWELL

NEW YORK

Binghamton June 21 & 22
Greater Binghampton Airshow

Ft. Drum June 28 & 29
Ft. Drum Centennial Celebration

Geneseo July 4–6
Historical Aircraft Group Museum Biplane Rally

Geneseo July 11–13
Geneseo Air Show—the Greatest Show on Turf

Rochester July 26 & 27
Rochester International Airshow (Thunderbirds)

Schenectady Sept. 6 & 7
ESAM Northeast Airshow

Wantagh May 24 & 25
New York Airshow at Jones Beach (Blue Angels)

NORTH CAROLINA

Jacksonville May 3 & 4
MCAS New River Airshow

Lumberton May 16–18
Mid-Atlantic Fly-In

MCAS Cherry Point June 7 & 8
MCAS Cherry Point Airshow (Blue Angels)

Monroe Nov. 7–9
Monroe Airport Veterans Day Celebration

Wilmington Apr. 19 & 20
Coastal Carolina Airshow (Thunderbirds)

Winston-Salem Sept. 6 & 7
Winston-Salem Airshow

NORTH DAKOTA

Grand Forks AFB July 19
Thunder Over the Red River

OHIO

Akron June 14 & 15
Wings Over Akron

Cincinnati Sept. 13 & 14
Blue Ash Airport Days

Cleveland Aug. 30–Sept. 1
Cleveland National Airshow (Blue Angels)

Coshocton Sept. 20
Coshocton Airshow

Dayton July 19 & 20
Vectren Dayton Airshow

Willoughby July 11–13
Gathering of Eagles

OKLAHOMA

Altus AFB May 3
Altus AFB Airshow

Tinker AFB May 24
Star Spangled Salute (Thunderbirds)

Vance AFB Oct. 4
Partners in the Sky (Thunderbirds)

OREGON

Klamath Falls June 21
Klamath Airshow (Thunderbirds)

Madras Aug. 22 & 23
Central Oregon Airshow

PENNSYLVANIA

Lititz Aug. 23 & 24
Lancaster Community Days Airshow

Pittsburgh May 10 & 11
Wings Over Pittsburgh (Snowbirds)

Reading June 6–8
World War II Weekend

West Chester Oct. 11 & 12
Rotorfest All Helicopter Show

RHODE ISLAND

North Kingstown June 28 & 29
Rhode Island Open House & Airshow

SOUTH CAROLINA

Anderson May 7
Anderson International Airshow (Snowbirds)

Anderson Aug. 29–Sept. 1
The Great Southeast Balloon Fest

Charleston AFB Apr. 26

Charleston AFB Air Expo (Thunderbirds)

Florence May 24 & 25
May Fly Airshow & Festival

Lancaster May 17 & 18
Lancaster Airport Community Days Airshow

Liberty May 8
Champion Aerospace Airshow

Myrtle Beach June 5–9
Sun Fun Festival Airshow

TENNESSEE

Jackson Oct. 4 & 5
Skyfest Tennessee

NAS Kingsville Apr. 5 & 6
NAS Kingsville Open House

Smyrna Apr. 12 & 13
The Great Tennessee Airshow (Blue Angels)

Union City Sept. 20
Union City Airfest

TEXAS

Austin Apr. 19
American Heroes

Burnet Apr. 12
Bluebonnet Airshow

Denton June 14
Denton Air Fair

Dyess AFB May 3
Dyess Airshow

El Paso Oct. 4 & 5
Amigo Airsho (Snowbirds)

Ft. Worth Oct. 11 & 12
Ft. Worth Alliance Airshow (Thunderbirds)

Galveston Apr. 26 & 27
Lone Star Flight Museum Spirit of Flight

Gilmer May 17
Flight of the Phoenix Armed Forces Day

Houston Oct. 24–26
Wings Over Houston (Thunderbirds)

Laughlin AFB May 10
Air Amistad

Midland Sept. 20 & 21
FINA-CAF Airsho

NAS Kingsville Apr. 5 & 6
NAS Kingsville Airshow (Blue Angels)

San Antonio Nov. 1 & 2
Lackland AFB Airshow (Blue Angels)

Temple May 4–6
Central Texas Airshow

Tyler July 4 & 5
Pinnacle Military Family Support Airshow

Waco Nov. 8
CAF Ranger Wing Airshow

UTAH

Wendover Airfield Sept. 20
Wings & Wheels at Wendover

VIRGINIA

Brandy Station Oct. 11
Culpeper Regional Airport Annual Air Fest

Danville May 31 & June 1
Southside Sky-Fest

Langley AFB June 20–22
AirPower Over Hampton Roads

Suffolk June 14 & 15
Virginia Regional Festival of Flight

Virginia Beach Sept. 20 & 21
NAS Oceana Airshow (Blue Angels)

WASHINGTON

Arlington July 9–13
Arlington EAA Fly-In

Fairchild AFB Aug. 8–10
Inland Northwest Skyfest (Blue Angels)

McChord AFB July 19 & 20
McChord Air Expo (Thunderbirds)

Olympia June 14 & 15
Olympic Airshow Gathering of Warbirds

Seattle June 14
American Heroes

Seattle Aug. 2 & 3
Seafair Airshow (Blue Angels)

Tacoma July 4
Tacoma Freedom Fair Airshow

Tri-City Sept. 24
Wings Over Washington Wine Country (Snowbirds)

WEST VIRGINIA

Parkersburg Sept. 28
Parkersburg Airshow

WISCONSIN

Baraboo June 27–29
Baraboo-Dells Airshow

Eau Claire Sept. 13 & 14
Chippewa Valley Airshow (Blue Angels)

Janesville May 24 & 25
Southern Wisconsin AirFEST (Snowbirds)

Manitowoc June 7 & 8
Thunder on the Lakeshore

Milwaukee July 12 & 13
Milwaukee Air Expo (Thunderbirds)

Oshkosh July 28–Aug. 3
EAA AirVenture

WYOMING

Cheyenne July 23 (Thunderbirds)

Powell Aug. 15 & 16
Wings 'N' Wheels

Air & Space/Smithsonian 2008 U.S. Airshow Schedule

SCHEDULE INFORMATION provided by the Department of Defense and the International Council of Air Shows (*www.airshowbuzz.com*, phone 703-779-8510) as of February 2008. Subject to cancellation or change of city, date, name, and performers. Check local listings.

AFB	Air Force Base
ANGB	Air National Guard Base
ARB	Air Reserve Base
EAA	Experimental Aircraft Association
JRB	Joint Reserve Base
MCAS	Marine Corps Air Station
NAF	Naval Air Facility
NAS	Naval Air Station
USAF	United States Air Force

COURTESY MARGI STIVERS

COME AND
SEE THE
SHOW
SUMMER
2008

My Wingwalker

IF YOU THINK IT'S NERVE-WRACKING ON THE WING, TRY BEING THE ONE IN THE COCKPIT.

BY DEBBIE GARY

WHEN I WAS A YOUNG AIRSHOW PILOT, I couldn't understand what people found interesting about wingwalking. Most of what I saw was wing-riding, not wingwalking: A girl straps herself to the top wing; the pilot flies gentle aerobatics; she waves, he lands—exciting as Little Bo Peep.

In 1975, I met Rick Rojatt, the Human Fly, who was always in his Spiderman-style costume, even at the T.G.I. Friday's bar after the show in Lancaster, Texas. When he started moaning about his ride on top of a DC-8 airliner—how dangerous it was, how he thought he would not survive—I sipped my beer and thought, *What a crybaby! How soon can I politely wander off to talk to the Red Devils or one of the cute and macho military pilots?*

It wasn't until 26 years later, when I briefly had a wingwalker of my own, that I finally understood what he was whining about: By flying rough, the pilot really can break the wingwalker's neck; he can cause her to black out; if he does not know what he is doing, he could rip her arms out of their sockets.

For many years, the world's top wingwalking act was the late Jim Franklin's. He had been flying a wing act in his Waco since 1970 and occasionally had other pilots fly a wing act in his second Waco. Franklin had modified both airplanes extensively over the years, and in 1998 he added a jet engine to one to create a one-of-a-kind Jet Waco. The following year, his son Kyle wingwalked on it. The Jet Waco wing act became so popular that Franklin could not fill all the show requests. He wanted to offer something new, and in 2001 he called me.

Kyle, who grew up in and on his father's airplanes, had been wingwalking since 1997, when he turned 17. Over the next couple of years he would transition from stuntman to stunt pilot, flying shows himself in the piston Waco. In the interim, Franklin had wingwalker Carol Pilon flying with him. "What would you think about flying an all-women wingwalking act with Carol?" he asked me.

"I'm not sure," I said, since I had never flown either of his Wacos or a wingwalker before. "But I'll come find out."

Pilon saw wingwalking on TV in 1993 and became smitten with it. She had learned to fly, but had no airshow connections and no idea about how to become a wingwalker. There is no wingwalking school, no club to join, no sure-fire path to getting up there. Everyone's wingwalking background is different.

Stuntman Johnny Kazian started out as a trapeze artist and in 1970 became Joe Hughes' wingwalker. Lee Oman, a pilot and parachutist, caught a ride on a neighbor's Stearman wing and became Jim Franklin's

RICHARD VANDERMEULEN

COURTESY DEBBIE GARY

Opposite: Pilots strive to showcase their wingwalkers; self-described hood ornament Margi Stivers arches into a back bend and beams at Stearman pilot Hartley Folstad, who is also her husband. Left: Tony Kazian rides Dave Dacy's Super Stearman wing. Above: Wingwalker Carol Pilon introduced author Debbie Gary (at right) to the art in 2001 in Jim Franklin's Waco.

Teresa Stokes high-fives Gene Soucy in the *Show Cat*, a tricked-out Grumman Ag Cat (above), and strikes a seemingly carefree pose in the wing wires (right). She has wingwalked on the *Show Cat* for 20 years.

wingwalker after crewing for him at airshows. Pilot Teresa Stokes went for a joyride in 1989 on aerobatic champion Gene Soucy's *Show Cat* and has been his wingwalker ever since.

At the other extreme, when friends suggested Margi Stivers get up on Hartley Folstad's Stearman wing, she first said "Absolutely not." But with her background as a pilot, dancer, and gymnast, she was a natural, and in 1991 she joined the Silver Wings Wingwalking team.

Stivers is the one who gave Pilon a chance to see if she liked wingwalking. In February 2000, Stivers coached her for a day and Folstad took her flying.

"What was it like?" I asked Pilon when we met.

"The first thing that happens is you stick your arm out to reach for the handhold on top of the airplane and your arm almost gets ripped out of its socket," she said. "Then you stand up and scrunch down into the wind blast, kind of like moving through rushing water. You never forget that first blast of air."

She made it onto the top wing, rode a while, then climbed back down. The following summer she hooked up with Jim Franklin, and the summer after that she and Kyle trained me.

Jim flew with me in his Super Cub—the piston Waco has only one cockpit with flying controls. He

TYSON RININGER

was not sure a woman would be strong enough to manhandle the Waco and counteract the drag of a wingwalker. It's a big lumbering elephant of an airplane, and it does take muscle to push and pull it through aerobatic maneuvers, but I loved the feeling of using all the strength I had to get an airplane to respond. I flew it solo for a while, then I was ready for my first flight with a wingwalker.

Wingwalking is a circus act. The high wire, the flying trapeze, the act with no net: You produce all these by flying. But first you must master the airplane. I could do that. Then you put a performer on the wing. That person, lightweight and streamlined in a leotard while standing next to you, is in the air

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transformed to a sack of concrete on a see-saw.

You must deal with this surprise on your first flight. I could do that too. What I was not sure about was the idea of someone's life loose on my wing. I'd seen *The Great Waldo Pepper*; I'd seen the wingwalker fall off. Never mind that it was just a movie stunt.

After days of flying and nights of listening to tales of wingwalks gone bad, I slowly taxied out with Pilon standing on the left wing, by the front cockpit. When I got to the end of the runway, I went through my pre-takeoff checklist, and Pilon hooked on her safety cable, climbed onto the javelin—a two-foot-long horizontal wooden bar attached to the flying wires to dampen vibration—and stretched out like Superman. We nodded at each other and I started down the runway. At liftoff, the left wing dipped under her weight and I used the ailerons to bring the airplane back to level. My mouth felt like it was stuffed with cotton balls.

After climbing to 3,000 feet, we nodded again, and she climbed off the javelin and headed for the fuselage. As she stood up, the airplane yawed toward her. I straightened it with rudder and pulled the throttle back so Pilon could walk behind the propeller blast without being blown off the wing—at full power the blast is probably 200 mph. She walked swiftly but carefully over the lower wing, putting her weight on the ribs and avoiding the fabric between them.

She stepped up into the front cockpit, then reached for the top wing. The airplane bucked as she climbed up. She got in front of the wingwalker's supporting rack, strapped herself in, then turned, nodded, and gave me a thumbs up. I was still nervous, but I grinned. I could do this. I dived for my first wingwalker's loop.

Pilon was a skinny girl, but the airplane went downhill like a truck in deep mud. She had told me that when she is on the top wing, the wind buffets her body, and I could feel the buffeting through the fuselage. The faster I flew, the worse it was for her, but I needed 140 mph for a loop.

"As the plane dives, the pressure builds, and you have to do shallow breathing to suck air," she told me later. "You have to tense every muscle to resist the wind, or you won't be able to breathe, the wind will grab your arm and break it, and you'll probably snap your neck off."

I kept diving. If she were sick, dehydrated, or extremely tired and I pulled excessive Gs, she might black out. Her body would go slack, and the wind would grab her arms, legs, and head, and her neck could break. Both she and Kyle had had moments when they started to "gray out," the first step toward blacking out. Luckily, Jim Franklin had the walkers wave their hands behind their backs to signal *Stop*.

As I maneuvered, I kept checking on her posture. When I pulled up, I did so gently at first, then harder so the airplane would fly all the way around the loop. As I did, I thought of what legendary aerobatic pilot Marion Cole told me about taking a friend for a ride on the top wing of his Stearman during a practice session for the Cole Brothers act in the 1950s. Back then, a wingwalker did not have a vertical post behind his back. He was secured to the wing by four wires that stayed tight as long as he was standing. As soon as the G forces piled on Marion's rider, his knees buckled. The wires went slack and he fell off the back of the wing, hit the windshield, cut his head,

TYSON RININGER

Kyle Franklin goes with the flow on the wing of his father's jet Waco at the 2003 California International Airshow.

In 1919, Ormer Locklear kicked off the wingwalking craze by cavorting on a Curtiss JN-4D Jenny (below, left). The Cole Brothers (below, right) took it up a notch in the early 1950s with a three-Stearman wingwalking act and an inverted ribbon cut.

NASM (SI-85-12329)

COURTESY MARION COLE

RICHARD VANDERMEULEN

Below: Peggy Krainz makes a point to pilot David Potuznik before they go for a spin over Gmunden, Austria (above). Krainz is also a general aviation flight instructor and plans to train wingwalkers.

and slid upside down into the front cockpit.

I flew around the loop, grateful for all the hard lessons people had learned before me. Pilon looked fine up top, so I kept the maneuvers going: barrel roll, hammerhead, snap roll, Cuban 8, then inverted flight. That was enough for our first time out, so I rocked the wings, Pilon climbed down, and we headed back to land with her strapped in the front cockpit on top of the smoke tank. It was the only time she would stay put: She wanted to be outside, on the wing, all the time.

I began to fly a longer, more complete routine. After takeoff, Pilon stayed on the javelin while I did a series of maneuvers, careful to keep the G forces positive, as negative Gs would fling her off her perch. I saved the hesitation rolls, inverted flight, and snap rolls for when she was up top.

The point is to showcase your wingwalker, like a ballet dancer showcases his ballerina. Put her first. Fly the airplane so spectators can see her move across the wing. Fly at an angle to silhouette her as she moves from javelin to cockpit. Get low and slow when the aerobatics are finished and she is hanging behind the wing rack like a hood ornament.

I did only a few wingwalking performances over two summers, so my show remained fairly simple. But Jim Franklin, who did not know the meaning of restraint, did some extraordinary maneuvers. His wingwalkers had to be tough.

"He put us through the wringer," Kyle says. "He was the first to do a torque roll and a tailslide with a wingwalker and even did a lomcevak and inverted three-ribbon cut with Kazian for 'That's Incredible.'"

In a tailslide, the airplane starts out pointed straight up, then slides backward until it whipstalls forward or back and then falls. In the torque roll, the aircraft does the same thing, but rolling as it descends tail-first. Kyle describes it from on the wing: "Once you get to the top of the torque roll, you don't realize you are moving. The engine is going full blast, but you

CORNELIUS BRAUN

CORNELIUS BRAUN

ing with your head that close to the ground sounds outrageously scary.

In 1975, Joe Hughes, who had one of the most spectacular wing acts of the decade, did get too close to the ground. Right before doing his act at Reno, where the high desert air is thin and quirky, a World War II T-6 trainer slammed into the ground during an air race. The show manager launched Hughes to keep the action going. All was well until he rolled over for an inverted ribbon cut. Then a fierce downdraft pushed the Stearman down. The wingwalker, gymnast Gordon McCollom, was killed when his body scraped the ground. The Stearman's rudder ripped off before Hughes could climb again, roll upright, and land the airplane.

Pilon and I flew only two shows. The first was at Joplin, Missouri, in June 2001, right after she and Jim Franklin got married; the second was at the Harley-Davidson rally in Sturgis, South Dakota, in 2002, shortly before they split up. Now she has her own act, Third Strike Wingwalking, with her own Stearman and three pilots she trains herself.

I haven't seen the Human Fly lately, but when I do, I owe him an apology.

For some wingwalkers, a big biplane and a thundering radial engine are optional. At the Chanute Air Festival in Rantoul, Illinois, last August, Jenny Forsythe stood tall on Bob Essell's Quicksilver MXL II ultralight.

COURTESY MICHAEL GALLAGHER/BOB ESSELL AIRSHOWS

are not moving anymore. The wind dies down and you could strike a match. Then you don't realize you are falling backwards until you start going back through the smoke, and then, as soon as you fall out of it, you have that sudden jolt of it falling over on its back, or forwards. Then Dad normally pulled around for a snap roll, which was like being a ball on the end of a string."

Pilon says, "With the snap roll you get swung out, then you get stuck in this negative-G kind of area where you are almost floating, then all of a sudden you get snapped back into the rack again and you are going the other way, like a zigzag carnival ride."

During the lomcevak, which is a wild series of twists with an end-over-end tumble, Kazian wore a parachute, though normally a wingwalker never would. Kyle says, "If the parachute ever got snagged and opened accidentally, all the flying wires become giant razor blades, the whole airplane becomes a shredder as it pulls you through, and you are going to destroy the airplane as you go."

In the early 1950s, Marion Cole and his brothers Duane and Lester did a three-airplane, three-wingwalker act in which Marion rolled inverted and cut a ribbon with his wingwalker on board while his brothers stayed upright, flying formation on his wings. Cole says all the wingwalkers used to fight for the chance to do it with him, even though fly-

COME AND SEE THE SHOW
SUMMER 2008

Ladies and Gentlemen: The Aeroplane!

To introduce Wright airplanes in 1910, a team of showmen flew death-defying stunts. Sometimes, death won.

by Paul Glenshaw

IT'S A RARE FILM, and we're lucky to have it. The cameraman must have had nerves of steel. Standing in the middle of a St. Louis, Missouri field in October 1910, he cranked his camera as the big Wright biplane took off and flew straight at him. It approached quickly, climbing, then suddenly pitched forward and dove for the ground. Closing fast, it pulled out, dashed its wheels on the ground with a cloud of dust, and rose—right over the photographer's head.

The pilot might have laughed, or maybe he was sweating. Fans, promoters, reporters, his boss, and fellow pilots were all watching him do his best to show off a new technology. It was another typical day for the Wright exhibition team.

For 16 months, from June 1910 to November 1911, the team members performed at air meets across the country, uncrating their aircraft from rail cars, thrilling crowds, haggling with promoters, perplexing their bosses, falling in love, getting divorced, counting gate receipts, and setting aerial records. With their American and European rivals, the Wright exhibition pilots introduced the airplane in dozens of towns across the United States. "All you have to do is look at some of the newspaper reports to see just how stunning the exhibition flights really were," says Tom Crouch, author of the Wright brothers biography *The Bishop's Boys* and a National Air and Space Museum curator. "People were fainting. People were absolutely dumbfounded to see this thing in the air. It's clear that the exhibition teams had an extraordinary psychological impact."

A year before, the Wright team members were scattered around the country, unaware of one another. Arch Hoxsey, soft-spoken and always impeccably dressed, lived with his widowed mother in Pasadena, California. When he wasn't chauffeuring his wealthy employer, he was earning a reputation as a gifted mechanic. Ralph Johnstone had left Kansas City, Missouri, far behind to perform a bicycle stunt act on the vaudeville circuit. Strapping and jovial, he could hop the bicycle up a flight of stairs, and, as a grand finale, flip it in a mid-air forward somersault. At 31, Frank Coffyn was the oldest of the group and probably the wealthiest. He was growing bored with his desk job in the well-heeled New York City business world. Philip Parmelee was testing automobiles for Buick and living with his parents in St. Johns, Michigan. Al Welsh had come the farthest. Born in Russia, he grew up as Liebel Wellcher in the Jewish neighborhoods of Philadelphia and Washington, D.C. He changed his name when he joined the Navy, and later took a job as bookkeeper at a Washington, D.C. gas company.

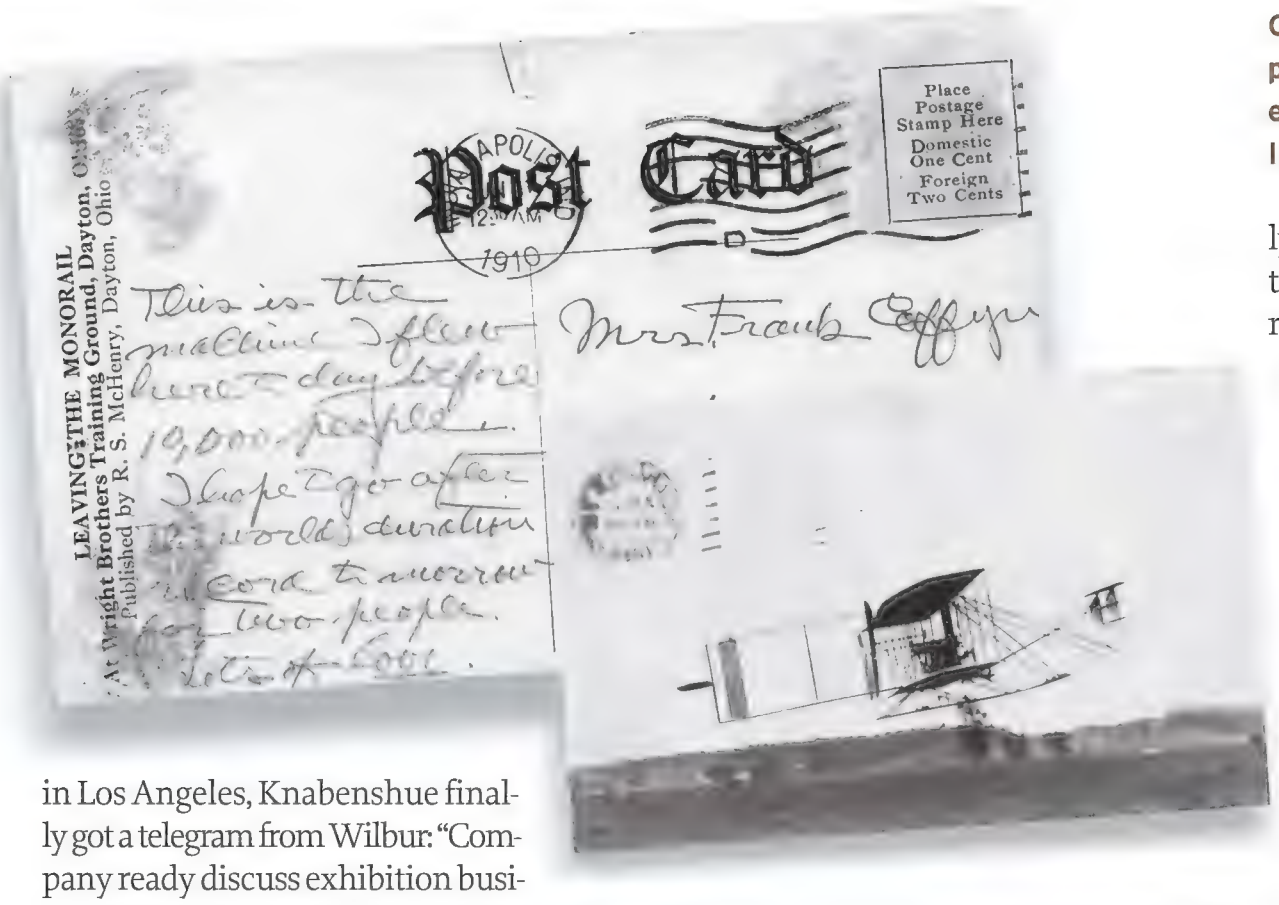
Three of the Wright team members were, like the Wrights themselves, from Dayton. Spencer Crane was a mechanic, as was Clifford Turpin, an engineering graduate from Purdue University who had returned to the city to start a motorcycle business with his father. Then there was Walter Brookins. A fixture at the Wright bicycle shop, he had known the brothers since he was four. Orville and Wilbur's schoolteacher sister Katharine had taught him in high school. The Wrights called him by his nickname, Brooky.

The Wrights had decided to form a team at the urging of others. The brothers deliberated for a long period over the decision. They had publicly demonstrated their airplane for the first time in 1908. Although powered flights had been made in Europe and the United States before then, other pilots could not control their machines as completely as the Wrights controlled their *Flyer*, and their rivals were stunned by the demonstration. But in Reims, France, in August 1909, at the first international air meet, the Wrights' arch-rival Glenn Curtiss won the signature event: the Gordon Bennett speed competition. If the Wright brothers were to hold onto the reputation their early demonstrations had won, they'd have to compete.

As the Wrights set about organizing their corporation in 1909, they were hounded by a genial but persistent Toledo, Ohio resident named Roy Knabenshue. He warned the Wrights that they should be represented at air meets, and, having toured the country since 1904 demonstrating dirigibles, he offered to be their road manager. In January 1910, as French pilot Louis Paulhan dominated the first U.S. meet,

Pilots on the Wright team were either natural showmen like Ralph Johnstone (above, right) or thrill-seekers like Frank Coffyn (at left). They flew a Wright biplane (opposite) at air meets across the U.S.

OPPOSITE & RIGHT: EMPIRE STATE AEROSCIENCES MUSEUM; FAR RIGHT: FROM THE COLLECTION OF RICHARDS AND JAMES FRENCH



Coffyn proudly told his wife about his performance at the team's first exhibition, which they flew at the Indianapolis Motor Speedway.

in Los Angeles, Knabenshue finally got a telegram from Wilbur: "Company ready discuss exhibition business seriously. When can you come Dayton."

In truth, Orville and Wilbur found the carnival-like atmosphere of the air meets distasteful. "They reluctantly got into the exhibition business," says Peter Jakab, a National Air and Space Museum curator of early flight. "They didn't really care for what they referred to as 'fancy flying'—the daredevil aspect of it. But they saw it as the viable way to make money with airplanes, and they wanted a chance to show what their technology could do. This was a way to put Wright aircraft on view."

Wilbur headed south to search for a winter training field far from the Ohio cold. He settled on a site just outside Montgomery, Alabama. In March, Orville arrived with Brooky, Hoxsey, Welsh, Crane, and a mechanic named James Davis to begin training. Time was running short (their first performance would be in June). By today's standards, Orville's goal was audacious: Train a group of complete novices to fly and compete as professionals in less than four months.

Brooky, 21, was the first to be trained. Beginning as Orville's passenger, he soon mastered stalls, takeoffs, and landings. Orville was impressed, writing to Wilbur: "Brookins is a first class man. You can give him a job and it is attended to...." The feeling was mutual. Brooky said Orville's training "was so thoroughly explained and demonstrated that you never forgot it." He immediately became an instructor. Orville then returned with Welsh to Dayton, trusting Brooky to continue training Crane and Hoxsey.

Essentially free to do as he pleased, Brooky experimented with flying techniques and taught himself stunts. Under a full Alabama moon, he and Hoxsey made the first recorded night flights, circling the field for hours. Later, Brooky took Crane up for a training flight, taking off toward the edge of the field, which was bordered by a road and telephone lines. They rose slowly, and when Brooky realized he would not clear the wires, he calmly pushed the nose down, flying under them and between the poles. Completely unnerved, Crane was on the train home to Dayton that night, preceding his arrival with a telegram to Orville: "This and other things force me to decline to ride again here.... With me it is a matter of needless risk. If you feel this is a lack of nerve my resignation is in your hand. Without hesitation I advise closing camp at once."

By the end of May it was warm enough for Orville to move the training camp to Dayton. The team had just three weeks to practice before heading to the brand-new Indianapolis Motor Speedway for their first performance. The night before the meet, the pilots were handed contracts, offering $20 per week and $50 per day of flying. They were responsible for seeing to their own injuries. And in keeping with the Wrights' own practice, the pilots were asked to refrain from flying on Sundays, drinking, and gambling. The Wright Company would keep any prize money. Brooky balked, and almost all the others joined him. Coffyn, however, urged them to accept, and in the end all of the pilots signed.

Brooky quickly established himself as the star. On the first day of performance in Indianapolis, he broke the world's altitude record, rising to 4,939 feet. On June 16, his secret practice in Montgomery paid off. He rose several hundred feet, dove, and rolled into a 90-degree bank. Hauling

EMPIRE STATE AEROSCIENCES MUSEUM (3)

Between performances, Coffyn found the landing skids a good place to catnap.

EMPIRE STATE AEROSCIENCES MUSEUM

COURTESY SPECIAL COLLECTIONS AND ARCHIVES, WRIGHT STATE UNIVERSITY

To ship the airplanes from city to city via rail, teammates removed the tail boom, rudder, and elevators and stowed them between the wings. Right: Wilbur (facing camera) and Orville tried unsuccessfully to rein in their daredevil pilots, including Johnstone (at right), who was the first fatality.

back on the elevator, he spiraled the airplane through 360 degrees. Wilbur was astonished: "It was the most hairlifting performance I have seen. The circle was not over a hundred feet in diameter.... It was a beautifully executed feat, but the strains are too great to make such things safe for everyday work."

Over the next four months, the team traveled to 25 cities, from New Hampshire to North Dakota to Alabama, shipping themselves and their airplanes by rail and showing up at Fourth of July celebrations, state fairs, and tournaments. They garnered plenty of headlines:

"Goes Up 6,175 Feet in Wright Biplane; Walter Brookins Beats His Own World's Record in a Flight at Atlantic City."

"Airmen Play Tag With Moonbeams; Hoxsey and Johnstone Unexpectedly Make Two Night Flights at Asbury Park."

"Aviator Drops 800 Feet But Lives."

"Hoxsey and Johnstone Set Crowd Wild in Plane Tilting and Short Whirls."

There were some minor accidents and organizational hitches, but the experiment seemed to be working. By mid-1910, five pilots were on the road, and Knabenshue could have the team spread across five states at once. Better still, the receipts were good. At the end of August, Wilbur reported to Wright company board member Russell Alger that the team had earned $186,000 in exhibition receipts, outstanding contracts, and guarantees for upcoming meets in St. Louis and New York. Alger was delighted: "I had no idea we would have any such brilliant year. I have paid my way toward the Aviation Meet and I naturally hope we will do as well as you predict and I see no reason why we should not." Alger, like everyone else, was waiting for Belmont.

The International Aviation Tournament at Long Island's Belmont Park promised to be the largest meet ever held, bringing top aviators from Europe and the United States. For the Wrights, Belmont was of singular importance. Although it featured prizes for distance, duration, passenger carrying, altitude, and a race to the Statue of Liberty, the most anticipated event was the Gordon Bennett speed competition. Winning the Gordon Bennett would, the Wrights believed, maintain the reputation of their airplanes, which would help keep their order book full, allowing them to invest in further development.

Curtiss had won the prize in 1909, and afterward, Wilbur wrote to Orville with

FIND OUT MORE www.airspacemag.com WATCH VIDEO OF WRIGHT TEAM PILOT ARCH HOXSEY.

FROM THE COLLECTION OF RICHARDS AND JAMES FRENCH (2)

Clifford Turpin (hands in his lap) had no trouble finding people to ride along. Turpin and Philip Parmelee (left) later started a business in Venice Beach, California, selling joyrides in two airplanes they had rented from the Wrights.

plans for a racer. His calculations had a clear purpose: "I think it would be a mistake to get up a racer with less speed than 70 miles [per hour]. We ought to beat them badly if we go into it at all." The finished airplane was far different from anything they'd done before. It was tiny, with wings half the length of those on their standard machine. A monster V-8 engine replaced the four-cylinder version. The aircraft even had a flashy name: the *Baby Grand*. The day before the meet, Orville clocked in at a blistering 78 mph.

The Belmont meet began with miserable weather and few spectators, but it quickly gathered momentum. Thousands came to see the competition, the newspapers publishing long lists of society notables in attendance. As many as 10 aircraft could be in the air at once, and there were daily spectacles. Three days into the event, Johnstone and Hoxsey braved fierce winds to duel for altitude records. As they turned into the oncoming gale, their airplanes struggled to make headway, slowed to a hover, and began to fly backward out of sight. Hoxsey came down 25 miles from the racetrack. Johnstone landed even farther away—55 miles—but in the process set an altitude record. An ebullient Katharine wrote her father a postcard: "Yesterday was Wright Day all right. Johnstone holds the American record for height. Orv took our big (or little) racer and made almost seventy miles an hour."

On October 29, the Gordon Bennett race got under way, the teams taking turns in individual timed trials, flying 100 kilometers (62 miles) over a five-kilometer course. The Wrights' chief competition was Claude Grahame-White of Britain, flying a 100-horsepower airplane designed by French inventor Louis Blériot. Brooky, whom Orville had chosen to fly the *Baby Grand*, took to the field around 10 a.m. He rose quickly to make his first pass, the crowd cheering as he came into view and sped past the grandstand. With Orville, Wilbur, and the entire team fixed on him, Brooky was banking into the turn and coming around to officially begin the timed trial when the engine began making a strange noise. It turned out Brooky had lost four of eight cylinders, and the airplane began to drop.

The crowd could see Brooky struggling to keep the little racer from coming down too fast. It was level when it hit the ground, pitching forward and raising a cloud of dust. As the air cleared, Brooky was seen several feet away, staggering to his feet, clutching his sides, and finally collapsing to the ground. He was rushed to the hospital, severely bruised but otherwise uninjured. The *Baby Grand* was demolished. Grahame-White easily took the prize from the remaining contestants, flying nearly 10 mph slower than the *Baby Grand* had

flown during Orville's unofficial test run.

The *Baby Grand*, like the team itself, was an experiment. For the Wrights, a failure was disappointing, but it was an accepted part of the process of innovation. They had a lot of experience with risk, and faced the setback with firm resolve to compete harder than ever. But in the challenge they faced now, they risked more than a lost race or a wrecked aircraft. To keep the team competitive, the Wrights would have to keep up with the advancing technology they'd created. Unfortunately, the brothers had spent so much time filing patent infringement suits against Glenn Curtiss, their technology development had suffered. "After 1910, the Wrights were not building the leading aircraft anymore," says historian Jakab. "They were very much in the middle of the pack in terms of what they were producing. As far as the performance and reliability of their designs, they were starting to lag behind other aircraft, namely those of Curtiss and Blériot."

Still, the Wrights saw the team as a way to make money, and to keep the business profitable, they needed a full calendar and focused pilots. The team aviators, who had been on the road for five months, were young and easily diverted. "Be Careful Girls, In Flirting With the Wright Men," advised the *Dayton Herald*, printing two lists of team members: married and single. "All the Wright aviators from Cliff Turpin, who is only 21, and Brookins, who has not yet turned 22, up to Parmelee, who stands near 30, are held up as 'love premiums'.... The Wright septet has been worshipped by women, young and old, all over the land."

The brothers tried to counter the head-turning publicity and inclination to showmanship. Wilbur had already chided Hoxsey and Johnstone: "I am very much in earnest when I say that I want no stunts and spectacular frills put on the flights there.... Anything beyond plain flying will be chalked up as a fault and not a credit." Hoxsey was scolded with good reason: In Milwaukee he had hit a grandstand and injured a spectator, who sued.

The Wrights also began to have their doubts about Knabenshue, noting that as 1910 was ending, he had scheduled the team for only four events: Macon, Baltimore, Denver, and Los Angeles. They would soon learn that an empty schedule was not the worst problem a team could face.

In mid-November, Hoxsey, Brooky, and Johnstone went to Denver for a two-day meet at Overland Park. Late on the 17th, Brooky had finished flying, but Hoxsey and Johnstone were still in the air. Johnstone started to descend in a steep spiral, when Brooky noticed the airplane's wings oddly distorted. Johnstone was seen struggling with the controls as the airplane slammed into the ground. He was crushed in the wreckage. The newspapers reported a swarm of airshow spectators probing his mangled corpse for souvenirs, yanking a strut out of his body and stealing his gloves. Hoxsey landed and found Brooky at the wreck; together they pulled Johnstone out and drove off past a band playing ragtime.

Wilbur attended Johnstone's funeral in Kansas City, and the Wright Company established a generous annuity to support the pilot's widow. Wilbur tried to piece together from conflicting reports what had happened, and he wrote Orville detailed theories, but the brothers could arrive at no certainties except one: There would be no more taking chances. Wilbur sent Parmelee to Los Angeles with a special high-altitude Flyer—and instructions. The only one who would fly it was Parmelee, who had been trained by Wilbur personally. Brooky angrily objected. Wilbur fired back through Knabenshue: "After we lost thousands of dollars of prizes at Belmont...it would be crazy foolishness to put the only machine of the kind you have out there in the hands of untrained men...." He added in a telegram: "Do not use unless it will win."

The Los Angeles meet began in triumph. On December 30, Hoxsey climbed to 11,474 feet, a record. But Knabenshue's telegram to Wilbur three days later held no joy: "Meet closed today forty thousand Less the guarenters [sic] will pay us with prize money won. Arch Hoxsey will be cremated tomorrow at two-thirty."

On New Year's Eve, after climbing to 7,000 feet, Hoxsey had started to descend—steeply. Knabenshue reported the details in a letter to Wilbur: "His angle of descent...would figure about 80 degrees from the 1000 foot level, and this angle never changed until he struck.... Firmly believe the poor boy had either been dead in his seat, or in some manner beyond control, for the machine continued to turn, striking head on.... I will not at this instance tell you the condition of his body...."

Brooky could add little. "I did not examine the machine or Hoxsey...as I had seen enough of the horrible."

The Wright Company established an annuity for Hoxsey's mother, who had been receiving $50 a month from her son.

Wilbur (holding onto the tail boom, suit wrinkled by prop blast) and Orville (standing at front, cap backward) had high hopes that the *Baby Grand* would win the speed contest at Belmont. But the little racer never made it to the final event.

NASM (SI A-3486)

EMPIRE STATE AEROSCIENCES MUSEUM

Before becoming an exhibition pilot, Arch Hoxsey (right) had raced cars in Los Angeles. Coffyn (center) had a desk job in New York City's finance industry.

Parmelee and Brooky continued on to San Francisco, the only performance scheduled for the coming year. A winter flying school was set up in Augusta, Georgia, which Coffyn was to manage. The calendar was otherwise empty. Hoxsey's death had stunned the team into immobility, and it faced 1911 without a future.

Katharine reported that New Year's Day was "a night-mare for all. I am so sick of this exhibition business. It is so absolutely wrong."

On February 15, Knabenshue submitted his resignation, citing "considerable interference from several members of your organization." At the end of March, the Wrights countered, telling Knabenshue he would report directly to them. In the face of ever-increasing competition, the brothers decided to keep the exhibition experiment alive. Knabenshue accepted their counteroffer, and after three months of inactivity, went out to hustle for jobs.

Although the Dayton flying school was busy, the exhibition season looked bleak. Orville reported, "[Knabenshue] came back completely discouraged. He found that the Curtiss people have been out, while we were fooling around, securing our business.... The Curtiss outfit are taking work at one half to two thirds of our prices.... I told him he must take the work away from Curtiss, whether we made any money on it or not...." The calendar finally started to fill, and eventually the team had even more engagements than it had flown in 1910: from Miami to Walla Walla and Manitoba to Corpus Christi. Turpin's itinerary, for example, had him traveling to 14 cities.

Turpin had proved to be a valuable asset: He fulfilled his contracts, didn't crash, and was a favorite with the press. Brooky, on the other hand, was changed. "Brooky is also in the West, but we have lost all interest in him," wrote Katherine. "[H]e is so ridiculously conceited that his days of usefulness are just about over.... Now even Orv can't endure him." Orville confirmed his misgivings in a letter to Wilbur: "I think something is wrong with the machinery inside of [his head]; his whole manner is so entirely changed from what it was a year ago. He spends his whole time talking of his superiority, and of the small amount he is paid for his services." On May 21, Brooky's wife divorced him. Soon after, he quit the team.

In June, Orville assessed the team's finances and reported to Wilbur: "Our receipts to date amount to $22,540. Our expenses, not including the expenses of the New York office nor any expense for wear and depreciation of machines, amounts to $19,400." Wilbur understood: "If it appears that the exhibition business is not

On May 30, 1912, Turpin was flying at a racetrack in Seattle when his biplane flew into the grandstand. Turpin survived, but a spectator was killed. At left: A 1911 Illinois State Fair guest pass.

FAR EFT: FROM THE COLLECTION OF RICHARDS AND JAMES FRENCH; LEFT: FRANK JACOBS/SEATTLE POST-INTELLIGENCER

EMPIRE STATE AEROSCIENCES MUSEUM

Things were still going well for the team when Walter Brookins skimmed the waves at Atlantic City, New Jersey, during a week-long July 1910 meet.

really profitable, my idea would be to get out of it as soon as possible. Only big profits and a quick release from worry could compensate for putting up with it at all." The experiment was over.

Though Wilbur and Orville had excelled at aeronautical design, tasks like sales and marketing did not come naturally to them. "The Wrights weren't bad businessmen, but running a business was a whole lot tougher for them than the process of invention," says Wright biographer Crouch. "I think people sometimes have the notion that the Wrights were these guys who were on fire to go out and bore holes in the sky, and they really weren't. The charge that they had always gotten out of it was the whole business of solving difficult challenges that had beaten everybody else. 'Isn't it wonderful that all these problems have been preserved all these years just so *we* could solve them,' " is how Orville once put it.

In November, after meets in Chicago and St. Louis, the Wrights quietly released Knabenshue and the team (Welsh stayed on with the Wright Company as a test pilot). Coffyn went to work for the Alger brothers, thrilling enormous crowds by flying a Wright Model B over New York City. Turpin and Parmelee rented two airplanes and a tent from the Wrights and traveled to Venice Beach, California, where they sold rides.

By March 1912, Turpin wrote Orville that the upcoming season would be a busy one, and suggested getting a new Wright model for sale or rent. Orville replied that the airplane, a Model C, was "a dandy," and although they were undecided about an exhibition team for 1912, they thought that if they did go out on the road, they would prefer to use men they knew.

Two months later, any hope of a new team was dashed. Turpin and Parmelee took two airplanes to Washington state, where they got back into the exhibition business. On May 30, Turpin was landing in front of a Seattle grandstand when a photographer ran in front of him. Turpin pulled up and clipped a small pylon, and the impact pivoted him toward the grandstand. Terrified onlookers scrambled as his airplane slammed into the upper tier, instantly killing a spectator. Turpin was dragged unconscious from the wreckage, bruised but otherwise unhurt.

The next day, news broke that Wilbur had died in Dayton, succumbing to a month-long bout with typhoid fever.

The following afternoon, Parmelee took off in Yakima, Washington, and minutes later lost control in a gust, crashed, and was killed. Among his effects was an unopened letter from his father. "Glad to hear you say you were going to quit...be careful, boy and not get hurt. Be one of the boys who gets out of it before it's too late."

Two weeks later, while testing the new Wright Model C at College Park, Maryland, for the U.S. Army, Al Welsh was killed. He had just returned from Wilbur's funeral. Orville and Katharine now came to his, and once again arranged support for a grieving family.

There would never again be another Wright exhibition team.

Orville, Knabenshue, Brooky, Coffyn, and Turpin all lived into old age. Orville sold the Wright Company in 1915, and retired to a quiet life as an elder statesman of aviation. Knabenshue returned to dirigibles but ultimately left flying and went to work for the National Park Service. Brooky returned to and retired from aviation several times, but he was never again a star. Coffyn wound up in the helicopter business. Turpin retired to Cape Cod and never flew again.

In less than two years, the Wright exhibition team had performed 77 times. Despite the tragedies, the pilots had helped introduce the airplane to the public long before the era of barnstormers and the modern airshow. For the Wrights and their competitors, exhibition flying was an opportunity to earn money after years of inventing and investing, and the performances spurred the growth of the aviation industry. For the men on the team, it was a chance to leave an old life and go on an adventure, possibly grab some glory, and play a part in the new world coming. Whether they intended to or not, they delivered a powerful and indelible message: Flight is real.

The Misunderstood PROFESSOR

WHEN HE SUGGESTED IN A 1920 TREATISE THAT ROCKETS COULD REACH THE MOON, ROBERT GODDARD SPARKED A PUBLIC FRENZY.

BY FRANK H. WINTER

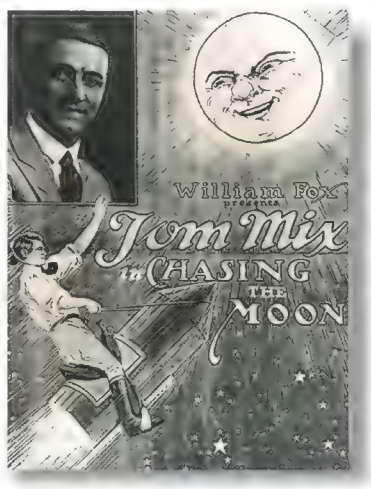
ROBERT GODDARD COULD scarcely believe his eyes as he scanned the newspaper the morning of January 12, 1920. A young physics professor at Clark University in Worcester, Massachusetts, Goddard had figured that the scholarly paper he gave to the Smithsonian Institution, his sponsor for high-altitude research, might attract attention. But not this: "New Rocket Devised By Prof. Goddard May Hit Face Of The Moon" screamed the front-page headline in the *Boston Herald*.

Goddard's treatise, "A Method of Reaching Extreme Altitudes," had been released to the public the day before, along with what was then a startling press release from the Smithsonian. Although the original release has not been found, all the major U.S. newspapers across the country quoted from it.

It was mind-boggling news, for two reasons. First, the very idea of flying in space was simply inconceivable when just seven months earlier, in June 1919, Britain's Captain John Alcock and Lieutenant Arthur Whitten Brown had notched a major milestone in aviation by completing the first nonstop flight across the Atlantic, a 16-hour journey they made at an average speed of 118 mph. Second, the average person in 1920 knew rockets only as the simplest kind of fireworks, something that flew up to 100 feet or so on holidays like the Fourth of July.

But here was the venerable Smithsonian touting a scientist who, the newspaper said, "had invented and tested a new type of multiple-charge, high-efficiency rocket of entirely new design for exploring the unknown regions of the upper air. The claim is made for the rocket that it will not only be possible to send it...beyond the Earth's atmosphere, but possibly even so far as the moon itself."

The *Herald* article went on to describe the rocket and explain how it could help study the upper atmosphere's chemical composition, temperatures, electrical properties, densities, and ozone content. But the newspaper, and many others across the country, chose to sensationalize what Goddard had intended as a strictly hypothetical exercise: to mathematically demonstrate the possibilities that a multi-stage, unmanned rocket could reach the moon.



The rocket concept was soon featured in magazines, movies, poetry, cartoons, and even music. Goddard would spend much of his career trying to knock down the misimpressions and rein in what he called "popular fallacies" about his treatise, which never mentioned manned spaceflight at all.

Goddard began his rocketry career in 1899, when at 17 he daydreamed of a spacecraft that could fly to Mars. The vision came to him after he read two serialized stories in the *Boston Post*, an adaptation of *The War of the Worlds* by H.G. Wells and *Edison's Conquest of Mars* by Garret P. Serviss. Goddard was so inspired that he vowed to devote his life to seeking a method to get into space.

Unknown to him, about 8,000 miles away, in Kaluga, Russia, a partly deaf schoolteacher named Konstantin Tsiolkovsky had already worked out the possibilities of spaceflight. In 1903, Tsiolkovsky's seminal article appeared in a popular scientific journal, *Naouchnoe Obozrenie* (*Scientific Review*). The title of the article, translated, was "The Exploration of Space by Means of Reactive Propelled Devices." The czarist authorities seized the journal because another piece in it was deemed politically subversive, but Tsiolkovsky continued to write about space. His articles were little known even in Russia, mainly because he could barely afford to pay for their private printing. Because of this, and the isolation of Russia from the West, his early works on space were then practically unknown in America.

The young Goddard, meanwhile, while studying for a doctorate in physics, spent years searching for the most practical way to escape gravity. It was not until

So popular was the rocket idea that it was even used to promote a movie that had nothing to do with spaceflight (above).

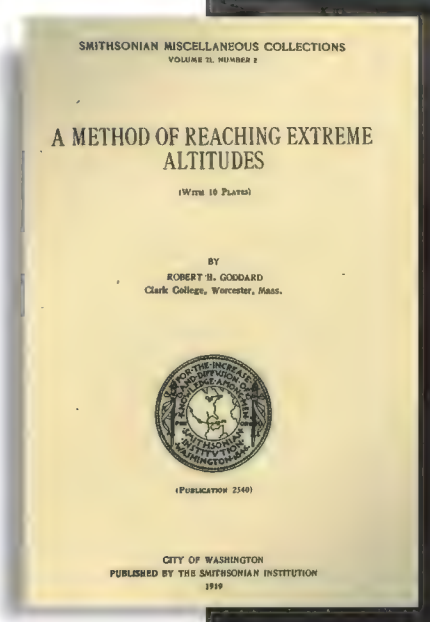
NEW YORK PUBLIC LIBRARY THEATER COLLECTION

1909 that he settled on the rocket as the solution. In 1915, drawing on his assistant professor's salary, he started experimenting with solid propellants. (He switched to liquid propellants in 1921, but did not announce his 1926 liquid-fuel rocket flight—the world's first—until a decade later.)

In 1916, Goddard conducted one of the most significant experiments in his career: He proved that a rocket could work in a vacuum. This was revolutionary: Throughout the 1,000-year history of rocketry, most people believed rockets needed air "to push against." But Goddard's experiments were expensive, and in 1917 he secured a $5,000 grant from the Smithsonian to continue them. He was secretive about his work, saying only that his rockets were for upper atmospheric research.

Later—reluctantly, at the goading of a colleague—he wrote up his results. *A Method* was a dry, academic treatise, full of scientific formulas detailing his research, including the vacuum experiments. But, out of his fixation on spaceflight and because he thought it would be read only by academics, Goddard included the theoretical exercise of mathematically demonstrating the maximum efficiency of multi-stage rockets. The keys to his rocket's long reach were multi-staging and the use of the de Laval nozzle—a tube with an hourglass shape that accelerates the flow of gas through it.

In all, 1,750 copies of *A Method* were printed (90 copies went to Goddard), and the Smithsonian sent out its press release to thunder-struck editors. Most of the newspapers regard-


SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 71, NUMBER 2

A METHOD OF REACHING EXTREME ALTITUDES

(With 10 Plates)

BY
ROBERT H. GODDARD
Clark College, Worcester, Mass.

(Publication 2540)

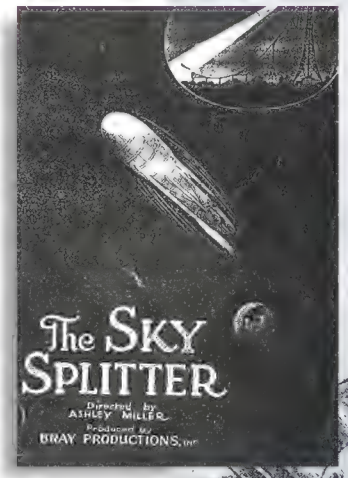
CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
1919

Shy and secretive, Robert Goddard had to be coerced into releasing his research paper.

COLLAGE: MUSIC AND NEWS CLIPS COURTESY OF FRANK WINTER, PHOTO:NASM (SI 73-1274)

ed the possibility of flight into space via a rocket with intense curiosity. Others treated Goddard's idea with amusement, and ran cartoons about it.

But there were criticisms too, some harsh. The most famous appeared in the *New York Times* on January 13, 1920, in which an editorial writer accused Goddard of being wrong and uneducated. Titled "A Severe Strain on Credulity," the writer chided the professor for his perceived ignorance: "Professor Goddard, with his 'chair' in Clark College...does not know the relation of action to reaction, and of the need to have something better than a vacuum against which to react." Goddard, the editorial sniffed, "seems to lack the knowledge ladled out daily in high schools."



LEFT: NEW YORK PUBLIC LIBRARY THEATER COLLECTION; RIGHT: SCIENCE AND INVENTION APRIL 1921

The 1922 animated film *The Sky Splitter* featured the incredibly fast, radium-powered Projectocar (shown in cutaway), which flew humans into deep space.

Goddard's initial reaction to the furor was summed up in a January 14 article in the *Boston Herald*. "His invention he will not discuss," the article said, recounting a less-than-fruitful interview that went like this:

Presenting a copy of his treatise to the *Herald* reporter, Goddard said, "That tells the whole story."

"But this 69-page pamphlet is so abstruse...," the reporter complained.

Goddard simply "smiled pleasantly" and replied, "It seems to me that it would be impossible for me to improve upon the plan."

"Just one question then," the reporter said. "How soon do you expect to be able to go to the moon?"

At this, "the professor began to pace the floor nervously."

"In self-defense," Goddard said, "I have to fight shy of the newspaper men." There was not only the risk of "being misunderstood," he explained, "but my inventions are being perfected under the supervision of the Smithsonian Institution."

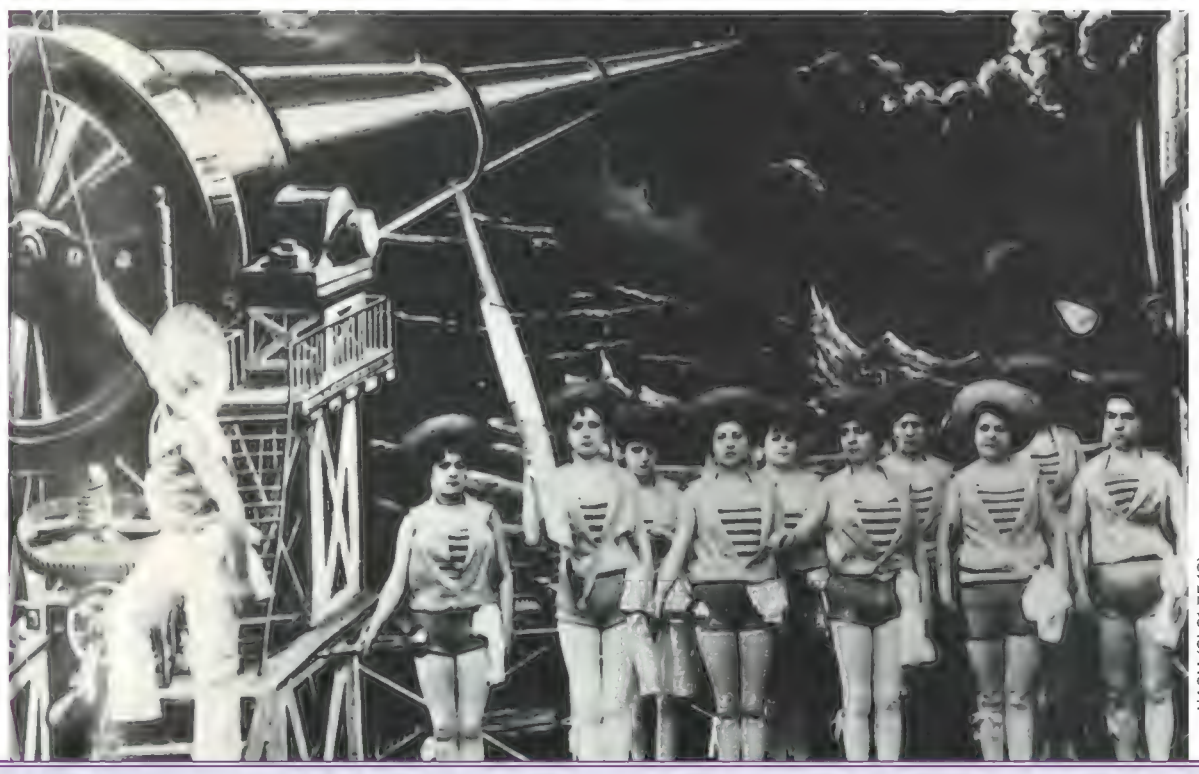
That last part was not entirely true. Although the Smithsonian expected and received regular reports of his technical progress, Goddard had complete freedom in his experiments and received no direct technical help from the institution. Goddard had assistants throughout his career, but he never revealed his overall plans to them, and in fact had his workers sign agreements not to reveal details of what they knew of his research.

It wasn't long, though, before Goddard, who subscribed to a news clipping service in New York City, began trying to correct the gross errors he saw in U.S. newspaper accounts of his work. The publicity continued for months, and spread around the world. Newspaper and magazine articles on his moon rocket appeared in Australia, Canada, England, France, Germany, Italy, the Netherlands, New Zealand, Russia, South Africa, and Spain.

Things began to turn bizarre when a Captain Claude Collins of the New York City Air Police volunteered to ride in Goddard's rocket—not to the moon, but to Mars. That, of course, encouraged others. In all, more than 100 people over the years volunteered to ride in the hypothetical rocket. Goddard characterized these people as "adventurers" rather than scientists. In speeches and interviews, he emphasized that it was far too early to talk about humans in space, when what was really needed was fundamental development of the rocket.

Goddard hoped he could turn the flood of unexpected publicity to his advantage and get the public to contribute to his experimentation (he estimated the cost at between $50,000 and $100,000). He was

Before Goddard's paper, space movies had no rockets at all; the launcher in 1902's *The Voyage to the Moon* (below), regarded as the first film about spaceflight, was a cannon.



NASM (SI 81-7542)

not averse to delivering public lectures on parts of his research, but at one point he complained to reporters, "I could get along a whole lot faster if there was less volunteering and more real support."

Overseas, the public reaction to Goddard's paper was no less enthusiastic. In Russia, enthusiasts first inspired by Tsiolkovsky's works formed rocketry clubs and put on exhibitions to promote Goddard's research throughout the 1920s (see "Russia's Long Love Affair With Space," Aug./Sept. 2007).

After Goddard's paper appeared, it didn't take long for Hollywood to catch moon fever. The first movie to depict a space rocket was *All Aboard for the Moon*, produced by Bray Studios and released in February 1920. It was a short, animated, educational movie directed by David Fleischer. (Fleischer's brother Max, who did the animation, went on to greater fame as the animator for such characters as Betty Boop, Popeye, and Superman.) Film producer John Bray contacted Goddard for technical help, but Goddard politely declined. Undeterred, Bray released a second space movie in 1920, *What It's Like to Live on the Moon*. Another of his films, 1922's *The Sky Splitter*, featured a radium-powered rocket that made it onto the cover of the French magazine *La Science et la Vie* (*Science and Life*).

Images of spacecraft from the Bray films helped spread the idea of the space rocket to wider audiences, even if the message distorted what Goddard was actually suggesting. Goddard's treatise clearly had an impact on movie makers of his day; before 1920, films about space did not have rockets at all. Georges Méliès' classic 1902 movie *Le Voyage dans la Lune* (*The Voyage to the Moon*), featured a giant cannon as the launcher. By contrast, a publicity photo for the 1922 film *Chasing the Moon* showed star Tom Mix straddling a moon-bound rocket. The movie went out to more than 20,000 exhibitors in a dozen countries.

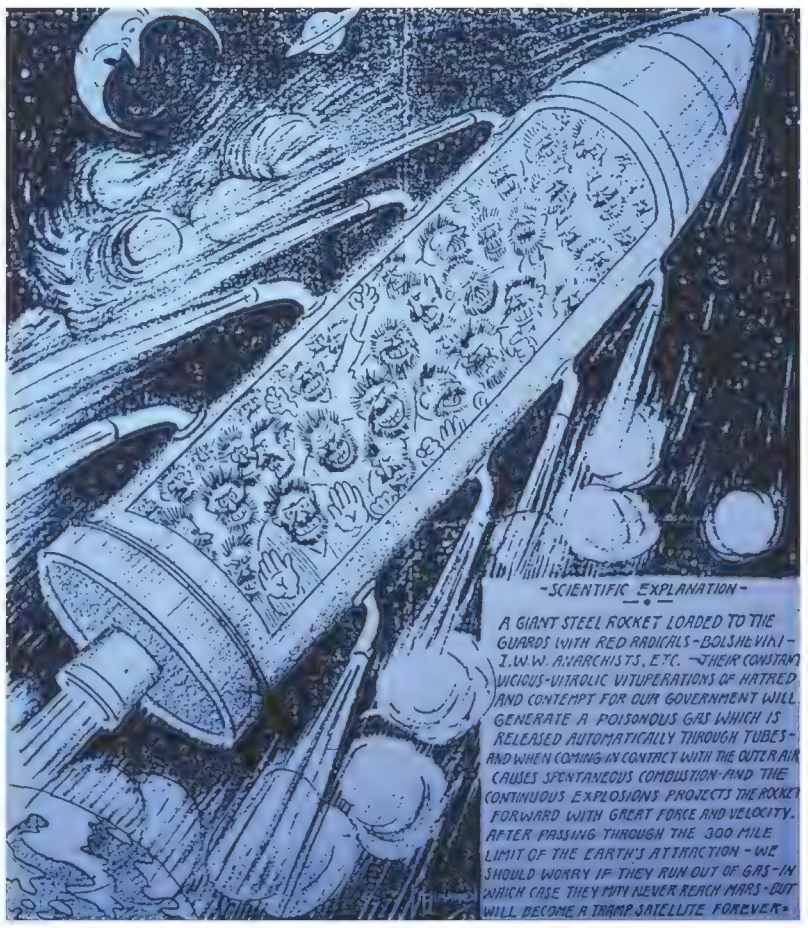
Early science fiction literature also toyed with the space rocket idea, but it took the publication of Goddard's treatise on rocketry for the idea to take hold in that genre. In a compendium edited by Everett Bleiler of more than 3,000 science fiction stories, the earliest mention of the rocket as a means of travel into space was in Cyrano de Bergerac's novel *The Comical History of the States and Empires of the Moon*, published in 1656. But considering that the title contained the word "comical," it was easy to dismiss de Bergerac's concept of the rocket as little more than a humorous literary device. His spacecraft, in fact, was only a box lifted up by ordinary fireworks.

Overall, the compendium showed that before 1920, only about five space stories featured rockets. Before Goddard, the most popular means of space propulsion in science fiction was anti-gravity, as featured in H.G. Wells' *First Men in the Moon*, published in 1901. The situation changed dramatically after 1920, with the appearance of the world's first sci-fi magazine, *Amazing Stories*, in 1926. For the next decade, the rocket was the preferred method of imaginary travel, appearing in 169 science fiction magazine stories, more than any other type of vehicle.

Adding to the rocket frenzy of the 1920s was the impact of another rocket pioneer, Rumanian-born (later German) physicist Hermann Oberth, whose book, *Die Rakete zu den Planetenräumen* (*The Rocket Into Interplanetary Spaces*), appeared in 1923. In many ways Oberth's book was far more advanced than Goddard's work, although it was strictly theoretical. For one thing, Oberth focused on the potentially more powerful and controllable liquid-propellant rocket, compared with Goddard's initial, solid-fuel rocket. For another, Oberth stressed human spaceflight, while Goddard had written of the unmanned rocket.

From the 1920s to the 1940s, Goddard's name was invariably brought up worldwide in any literature having to do with rockets. But from 1930 on, almost without interruption, he had become—except for a few assistants—the lone rocket experimenter at his isolated research station near Roswell, New Mexico, funded by the industrialist Daniel Guggenheim. In the end, Goddard preferred secrecy to publicity, and he remained aloof from an ever more crowded field of rocket experimenters until his death in 1945.

Although unintentionally, Goddard's treatise planted the seeds, both conceptual and technological, of the Space Age. While Goddard did not live to see that age unfold, his ideas were eventually accepted even by his critics. Almost 50 years after the *New York Times* had so blistered Goddard, it conceded in an editorial: "Further investigation and experimentation have confirmed the findings of Isaac Newton, and it is now definitely established that a rocket can function in a vacuum as well as in the atmosphere. The *Times* regrets the error." The retraction ran on July 17, 1969, as Apollo 11 streaked to the moon.



A cartoon in some U.S. newspapers depicted a rocket hauling unwanted Communist "radicals" to the moon. Lacking a real rocket to feature, the French magazine *Science and Life* (upper left) used the Projectocar.

LEFT: COURTESY FRANK WINTER; RIGHT: NASM (SI 82-8648)

The Bo

BELOW: SENIOR A.RMAN SEAN M. WHITE/USAF. RIGHT: TED CARLSON/FOTODYNAMICS.NET

TOO TROUBLE-PRONE FOR NUCLEAR ALERT AND SIDELINED IN THE FIRST GULF WAR, THE B-1 IS TODAY THE BUSIEST BOMBER IN THE FLEET.

BY DAVID NOLAND

IT'S ONE O'CLOCK IN THE MORNING on December 17, 1998, a cool crystalline night at Thumrait Air Base in the Persian Gulf sultanate of Oman. Two Rockwell B-1B bombers idle on Runway 17. Cleared for takeoff, the first jet begins to roll, its afterburners washing the rocky desert landscape in a faint orange glow. Quickly gathering speed, the Lancer lifts off the runway and banks into a sharp turn to the right, heading west. Forty-five seconds later, the second B-1B follows. The two jets join up in a loose formation and turn north into the starry blackness.

For the B-1, this is an historic moment: the long anticipated first combat mission of the complex, expensive, and oft-maligned bomber delivered to the Air Force 13 years earlier. Born amid controversy in the 1960s, twice canceled, and plagued early by technical problems, the B-1 had seemingly gotten lost in the shadows—caught between the Boeing B-52, the iconic bomber of the past, and the Northrop B-2, the stealthy bomber of the future. In 1990, the B-1 had suffered the ultimate humiliation: staying Stateside during the first Gulf War, while the plodding, antique B-52s answered the call to duty.

But now, in Operation Desert Fox, the

In a typical two-ship formation, B-1Bs fly a 1998 training mission near Meteor Crater in Arizona, one of the few holes in the ground bigger than a B-1 could make. That year, B-1s based in the Middle East (below) ended the bomber's losing streak.

ne Is Back

JOHN DIBBS/PLANEPIX.COM

With wings swept to 67.5 degrees and afterburners (below) kicking four turbofans to 120,000 pounds of thrust, the B-1 can make better than 900 mph at sea level.

four-day 1998 air campaign against Iraqi president Saddam Hussein, the B-1 was finally getting a chance to prove its worth. "Failure was not an option that night," recalls Lieutenant Colonel Gordon Greaney, a back-seat weapon systems operator on the trail aircraft. "We all had very big chips on our shoulders after the Gulf War." The B-1s were to take out the main barracks of Saddam's elite Republican Guard at Al Kut, 100 miles southeast of Baghdad. The two big jets would be escorted by a dozen carrier-based fighters and an EA-6B Prowler.

Joining up with the Navy aircraft, the two B-1s crossed the Iraqi border at 26,000 feet and 550 mph. They navigated around an Iraqi SA-2 surface-to-air-missile site, but two more sites, equipped with the more dangerous SA-3 missiles, awaited near Al Kut. Greaney, chewing tobacco and occasionally spitting to the side of his dangling oxygen mask, monitored the SA-3 tracking radars on his instrument panel displays. He watched as the SAM radars flicked on briefly, then shut down, the operators apparently fearful of the radar-homing missiles carried by the EA-6B. He breathed a sigh of relief: No SAMs tonight.

Approaching the target, the B-1 crews watched as orange streaks of anti-aircraft artillery fire arced far below them. Seven miles out from Al Kut, Greaney's B-1, nicknamed "Watchdog," released its load of 64 500-pound "dumb" bombs. The drop took only five seconds; the B-1 immediately racked into a steep 3-G right bank and headed back toward Thumrait.

It hadn't been a perfect mission—sand

OPPOSITE: TED CARLSON/FOTODYNAMICS.NET

RICHARD VANDERMEULEN (2)

in the bomb release mechanism had caused 20 bombs to hang up—but all in all, things had gone smoothly. After landing around 6:30 a.m., with the sun just rising off the left wing, Greaney crawled into his tent to sleep, exhausted and exhilarated. Not until the next night did he see the satellite photo that showed a tight cluster of marks centered on the barracks, with nearly a dozen direct hits. In the close, competitive world of bomber crews, Greaney and his mates had earned bragging rights.

For the B-1, the destruction of the Republican Guard barracks that night was the first step back toward respectability. (Two other Desert Fox missions were also successful.) Subsequent combat in Kosovo, Afghanistan, and Iraq confirmed its comeback. And last year, the B-1's tale of redemption reached an unlikely zero-to-hero ending: In Southwest Asia, the former Rodney Dangerfield of warplanes became the bomber of choice. Since April 2006, the fancy $2 billion stealth bombers have sat meekly in climate-controlled Missouri hangars or deployed to Guam for training exercises, and the B-52s have rested their weary combat wings Stateside, while B-1s have been flying almost daily against the Taliban. Tony Straw, a B-1 pilot with the Seventh Bomb Wing at Dyess Air Force Base in Texas, says proudly, "We're now in demand."

THE B-1 WAS BORN in a time of stormy debate about strategic bombing philosophy. Manned bombers or intercontinen-

Over Nellis Air Force Base, Nevada, a Ninth Bomb Wing B-1 releases flares and a cluster bomb; small parachutes arm, slow, and orient the bomblets. Above: Lieutenant Colonel Howard "Ace" Shrum of the 28th Bomb Wing watches the lead B-1B. If he were hugging terrain, he would see a desired flight path on the instrument panel screen.

RICHARD VANDERMEULEN

Technical Sergeant Cliff Young tightens shackles on a 2,000-pound JDAM, the weapon that reinvigorated the B-1B.

tal ballistic missiles? Penetrate or stand off? High altitude or low? The first casualty of the debate was also the Air Force's first stab at a B-52 replacement: the XB-70, a high-altitude Mach 3 marvel. Its radar cross-section and infrared signature would have made the aircraft an easy target for a new generation of Soviet missiles, however, and in 1961, Air Force planners turned their focus to a low-level, under-the-radar bomber. Numerous design studies ensued, with acronyms like SLAB, ERSA, LAMP, AMPSS, and finally, in 1964, AMSA, for Advanced Manned Strategic Aircraft. (Wags said that it stood for "America's Most Studied Aircraft.") But Secretary of Defense Robert McNamara, a believer in ballistic missiles rather than manned bombers, limited AMSA funding to a trickle. Worried that the B-52s would start suffering structural failures before a new bomber could replace them, the Air Force ordered an interim solution: the General Dynamics FB-111, which presaged many features of the bomber-to-come.

The new Nixon administration, however, revived the strategic bomber design, renamed it the B-1, and selected North American Rockwell to build it. The bomber on Rockwell's drawing board was in every way different from a B-52: a highly maneuverable Mach 2.2 low-level penetrator packed with advanced electronic countermeasures. Its mission: a terrain-hugging, under-the-radar nuclear attack on Moscow. And the B-1 looked like a weapon of mass destruction.

Its blended wing/body design and sinuous fuselage, shaped by the area rule, cut supersonic drag. The variable-geometry wing swept forward to 15 degrees for takeoff and landing, and back to a dart-like 67.5 degrees for supersonic dash. Its advances included terrain-following radar that enabled hands-off flying as low as 400 feet in any weather. To relieve the structural stresses of low-level turbulence on the long slim fuselage, small canard vanes below the cockpit automatically swiveled in response to gusts. To stay within center-of-gravity limits during wing sweep or weapons release, an automatic fuel-balancing system rapidly redistributed fuel among various tanks. A complex Defensive Avionics System was intended to detect and jam enemy radars.

The first prototype B-1A flew in 1974. Initial flight testing proceeded smoothly, but the B-1 continued to stir controversy on Capitol Hill, where critics sniped at its mission philosophy and constantly escalating cost. But its backers, led by right-wing firebrand Congressman Robert "B-1 Bob" Dornan, had managed to spread the B-1 subcontractor pork among many Congressional districts, a tactic that helped keep the project alive—until once again, political change rocked the B-1 program. Jimmy Carter, riding a post-Vietnam wave of skepticism about military power and citing budget concerns, scrapped the B-1 in 1977 in favor of the air-launched cruise missile (and, unbeknownst to the public, the stealth bomber, then in the early planning stages). But Carter did allow the four B-1A prototypes to continue testing.

Then came the presidency of the hawkish, free-spending Ronald Reagan, who revived the program. The new B-1B was beefier and could carry 50,000 more pounds of bombs and more fuel. A simplification of its engine inlets and a coating of radar-absorbing material would cut the jet's

radar cross-section by 90 percent. The new inlets' design limited top speed to Mach 1.25, but it was decided that stealth (or at least semi-stealth) trumped speed.

Even though testing at Edwards Air Force Base in California was barely half finished, the B-1B stood its first nuclear alert in 1986, at Dyess Air Force Base. The rush to duty had predictable results: Even as their price tags were rising past $250 million each—the most expensive warplanes in history at that point—the B-1s were plagued with teething problems. Engines failed. Fuel leaked. The ballyhooed radar-jamming system had an unfortunate tendency to disrupt the B-1's own offensive radar, prompting the *Armed Forces Journal* to award the bomber the mortifying title "World's First Self-Jamming Bomber."

For all its initial problems, though, the B-1 was loved by its pilots, who affectionately call it the Bone (for B-One). "Never call it a Lancer," one Bone jockey cautioned me. With a fighter-style stick control, a relatively snappy 40-degrees-per-second roll rate, afterburners for instant kick-in-the-pants power, and a generous 3-G combat maneuvering limit, the Bone flies more like a fighter than a bomber. During a ride in the left seat of the B-1 flight simulator at Dyess, I got a feel for the Bone's agility. A firm yank on the stick triggered a roll rate that left me dizzy.

At airshows, B-1s have done barrel rolls, maneuvers unthinkable in a B-52 or B-2. (Search *youtube.com* for "Inverted Bone.") Major Dave Arnold, a Bone weapons systems officer with the Seventh Bomb Wing at Dyess, smugly points out that the stealth bomber, for all its vaunted electronic gizmos, is limited to sedate 25-degree banks and typically flies programmed missions almost entirely on autopilot.

And of course Bone jocks are the only U.S. bomber pilots who can bust the Mach. A favorite B-1 combat maneuver in the Gulf is the "show of force" run, a low-level, full-afterburner flyby to let the bad guys know who's in the neighborhood. "It breaks some eardrums," says Arnold. "And it's a great morale booster for our guys on the ground." Even at subsonic speeds, a Bone at full afterburner is almost certainly the world's loudest aircraft.

Unlike its pilots, however, the B-1's ground crews have a decidedly mixed opinion of their complex, finicky, and trouble-prone charge. "It's a love-hate relationship," concedes Staff Sergeant Walker Grant, a Seventh Bomb Wing crew chief at Dyess. "It's a high-performance vehicle. You're always tinkering. Comparing what it takes to keep a B-1 in the air to, say, a C-130 is like comparing a NASCAR racer to a go-cart." On many Bone missions, it's standard procedure to keep a second aircraft standing by with engines running in case the primary aircraft has some last-second problem.

To keep glitches to a minimum, Dyess ground crews ritually rub certain spots on their B-1s before each takeoff. (Just which spot depends on the particular aircraft.) "I've never been in a culture as superstitious as Bone crew chiefs," admits one of them. Even when everything's working, about 90 man-hours of labor are needed to prepare a B-1 for a training sortie—double the number for a B-52.

Because of its very shaky start and high maintenance, the Bone had very low combat readiness rates during its early years on nuclear alert. The nadir came in 1990, when a series of engine fires grounded the entire fleet just before Iraq invaded

USAF

The U.S. Air Force bomber fleet: Big, fat, and ugly (top) and smart and stealthy (bottom) flank the linebacker.

MASTER SGT SCOTT WAGERS/USAF

Handing up food and survival equipment, weapons systems officer Captain Cedric Harper prepared for a 12-hour mission over Afghanistan in 2006.

On January 25, 2007, a B-1B awaited refueling on a hot ramp at a "forward deployed location," probably in Oman.

Kuwait. Bone pilots watched in envy and disgust as the B-52s flew off to the Gulf and glory.

But even had its engines been reliable and its defensive avionics working, the B-1 simply had no role to play in the first Iraq war. It was strictly a nuclear bomber, never intended for limited conventional wars, and not even capable of dropping conventional weapons. "It was horrible," recalls Colonel Jeff Taliaferro, a Bone pilot at the time who later flew the second Desert Fox mission. "Most of us had never been in combat, and we really wanted to go. When the nation's at war, you want to be part of it. The whole B-1 crew force was very disappointed."

AFTER DESERT STORM, the B-1 began the remarkable resurrection to its current status as America's go-to bomber. The first change in its fortunes was the 1991 collapse of the Soviet Union, which made the Bone's original nuclear deterrent role moot. Responding to the new strategic reality, the Air Force began to convert the B-1 fleet to carry conventional weapons. (The START arms reduction treaty later made the changeover mandatory.)

The following year, to compensate for the B-1's intensive maintenance requirements, the Air Force put 21 Bones on "attrition reserve," reducing the number of operational B-1s from 74 to 53. This allowed the available maintenance money, spare parts, and manpower to be spread over fewer aircraft. (Later, most of the "attrition-reserve" aircraft were retired altogether.) And a long-term program was initiated to improve the aircraft's computers, avionics, and weapons.

By the time of the 1998 Desert Fox operation, the upgrade was completed. Mission-capable rates had risen to the 70 percent range. And B-1 pilots, long steeped in SAC-style, low-level training, were now proficient in a whole new style of bombing: precision strikes with conventional weapons. This time when Saddam turned ornery, the Bones were ready.

The Desert Fox success earned the B-1 a big role in the Kosovo, Serbia conflict a few months later. Flying almost daily from Royal Air Force Base Fairford in England and using the same Mark 82 500-pounders and carpet-bombing tactic used in Desert Fox, a half-dozen B-1s dropped 20 percent of the total tonnage released by Allied air forces over Kosovo, while flying just two percent of the strike sorties. The B-1's first Kosovo mission, a raid on the Novi Sad oil refinery, was a baptism by fire; both aircraft were attacked by a SAM-6 missile. But the B-1s' new radar decoys, towed by the bombers on long cables, worked. The SAMs nailed the decoys, not the Bones.

Toward the end of the Kosovo campaign, the B-1B tried out a new Air Force tactic called time-sensitive targeting. Instead of bombing pre-arranged targets, the B-1 acted as a "roving linebacker," loitering over the battle area and awaiting target assignments from ground controllers. The B-1's speed, agility, payload capacity, and endurance made it ideal for this new kind of aerial warfare, enabling the Bone to strike multiple targets, on demand, during a single mission. Such a tactical role, of course, had never been envisioned by the B-1's designers. Yet here it was, an erstwhile intercontinental nu-

STAFF SGT JIM VARHEGYI/USAF

Follow the leader: A gaggle of international fighters trail a B-1 during a 1999 exercise over Giza, Egypt. Opposite: A B-1B from Ellsworth Air Force Base, South Dakota, ready to roll.

OPPOSITE: AIRMAN 1ST CLASS JONATHAN SNYDER/USAF

clear bomber acting like an F-16.

In Afghanistan in 2001, the B-1 finally put it all together. The new roving-linebacker role was a perfect fit for the Afghan theater, with its small mobile bands of enemies and ever-shifting battlefields. And the new 2,000-pound JDAM (Joint Direct Attack Munition) guided bomb, steered by GPS and accurate to within about 30 feet, proved to be the right answer for U.S. troops on the ground asking for close air support. JDAM-equipped B-1s destroyed the caves and training camps of the Taliban, with devastating effect. Air Force brass at the time credited the B-1 with a "very big part" in the rout.

By the time of the initial 2003 air campaign against Iraq, the B-1 and its JDAMs had mastered precision-strike-on-demand. During the first month of the war, a tag-team of 11 B-1s was over Iraq virtually 24/7, hitting a wide variety of targets within minutes of getting the call.

The Iraq war has since devolved into an urban civil and sectarian conflict in which aerial bombardment has little role, though on January 10 this year, two B-1s, joined by four F-16s, dropped 20 tons of bombs on what were believed to be militant hideouts and storehouses just south of Baghdad. And back in Afghanistan, the Bone has been raining JDAMs on a resurgent Taliban with such success that the B-2s and B-52s were sent home.

"In this war, at this time, the B-1 is the obvious choice," Colonel Jeffry Smith said last year, when he was commander of the 28th Bomb Wing, the B-1 unit currently deployed in the Middle East. "We're the one airframe that can carry all kinds of munitions, in large quantities, with a long loiter time. We can carry 500-pounders in the front bay, thousand-pounders in the middle, and 2,000-pounders in the back. You've always got the right bomb for the job, with a minimum of collateral damage. That's a great luxury for a commander." Recent civilian casualties in Afghanistan, however, are a grim reminder that even with highly accurate just-the-right-size bombs, targeting errors remain a serious problem.

Though it has found new esteem among Air Force brass, the B-1 may remain in the shadows of the B-52 and B-2, as far as the public is concerned. The Bone just missed a shot at stardom in 2003, during the initial strikes on Baghdad. Patrolling over western Iraq on April 7, the B-1B "Search and Destroy" got an urgent call from a nearby E-3 AWACS: a "high-priority leadership target" in Baghdad. It was The Big One, the AWACS operator reported. Translation: Saddam Hussein.

The jet banked sharply toward Baghdad and accelerated to Mach 0.9. Twelve minutes later, four 2,000-pound JDAMs slammed into the restaurant Saddam had been observed entering 47 minutes earlier. But the dictator had apparently decided to eat and run; by the time the bombs hit, he was gone.

Although the mission failed, it was a dramatic demonstration of the B-1's speed, range, flexibility, and targeting precision. And the Bone had not even flexed its muscles: A full-afterburner Mach 1.2 dash to the target would have gotten the bombs there six minutes sooner. Would those six minutes have made the difference? We'll never know.

OPPOSITE: TECH. SGT. EDWARD D. HOLZAPFEL/USAF

Sightings

PICTURES WORTH A SECOND LOOK

IS IT THE INTERIOR LIGHTING or the shadows cast by a full moon that animate these aircraft ruins, making them seem haunted by former crew and passengers? Since the 1990s, commercial artist Troy Paiva has been chasing ghosts with his camera in the twilight zones of abandoned towns, crumbling urban neighborhoods, and aircraft boneyards. For most of these shots he visited Aviation Warehouse, a scrap and salvage operation in California's Mojave Desert, during full-moon nights in 2006 and 2007.

"I always had a thing for junkyards," says Paiva, who has been exploring them and western ghost towns since he was a teenager. In the late 1980s, he sat in on a night photography class and thought, "Here's the way to show these places. Photographing them at night takes all the creepy, spooky, exciting atmosphere and multiplies it by 10.

"But to me it's like a Tim Burton spookiness. It's macabre, but there's a little wink to it. It's almost like I'm saying *nyah, nyah* and thumbing my nose at entropy."

Photographs like these can be seen on the photographer's Web site, *www.lostamerica.com,* where Paiva describes his lighting techniques and suggests the kinds of equipment that will produce similar images. He has also published two books of night photography. The latest is *Night Vision: The Art of Urban Exploration.*

Clockwise from top: A UH-1H Huey helicopter, now on permanent graveyard shift. (Note the eastbound airliner in the dark sky, a living thing in contrast to the scene below.) A paralyzed hull, probably of a once-vibrant Gulfstream G-200. The Mojave Airport boneyard in 1990. At Aviation Warehouse, an ancient airliner's broken fuselage.

Takeoff, Landing, and the Fun Stuff in Between

A new book explains what it takes to get airborne.

How to Fly a Plane

by Nick Barnard. Abrams Image, 2008. 128 pp., $19.95.

THIS BOOK WAS NEVER intended to be a flight instruction manual. It is, however, a well-photographed, three-part compendium of pilot knowledge, which fulfills its title promise with vivid descriptions of how an airplane flies and what's required of the pilot.

First chapter topics, such as aircraft structure, the forces upon an aircraft in flight, and flight controls, are discussed in a manner that does not require an aviation background to understand. The author moves from theory to practice in chapter two, where the reader is offered an opportunity to enter an airplane cockpit and follow a flight from preflight checklist, takeoff, and air maneuvers to landing and engine shutdown.

For his instruction aircraft, the author chooses the diesel-powered Diamond Star DA40 TDI. This exotically styled machine, with its composite construction and complicated-looking glass cockpit displays, might intimidate old-school pilots like myself, who learned to fly in aircraft with a handful of round instruments affectionately known by the (less than accurate) term "steam gauges." Readers familiar with video games and flight simulation software, though, will probably feel right at home.

How to Fly a Plane puts readers into the cockpits of several aircraft, including the P-51 Mustang (above).

The third chapter, "First Flights," places readers in the cockpit of all manner of air machines. Sit back, strap in, and enjoy the thrill of riding in aircraft ranging from sailplane, antique, aerobatic, jet-powered, ex-military, and large transport. Prepare yourself to exclaim "I have got to get me one of these!" after every section.

BOB McLEAN HAS BEEN FLYING LIGHT AIRPLANES FOR NEARLY THREE DECADES, AND IS HALF-OWNER OF A 1948 TEMCO SWIFT. HE RESTORES AIR- AND SPACECRAFT FOR THE NATIONAL AIR AND SPACE MUSEUM.

LUCY POPE

>>> At a Glance <<<

Milestones of Aviation

Edited by John T. Greenwood with Von Hardesty. Universe Publishing, 2008. 320 pp., $60.

With more than 400 photographs and illustrations and an introduction written by Apollo 11 astronaut Michael Collins, *Milestones of Aviation* provides a chronicle of the airplane's rapid advance.

Black Wings: Courageous Stories of African Americans in Aviation and Space History

by Von Hardesty. Smithsonian Institution-HarperCollins, 2008. 180 pp., $21.95.

Von Hardesty, the National Air and Space Museum's curator of African-American aviation history, offers a thorough overview of 80 years of black achievement in aerospace.

Wings Over the Yukon

by Bruce McAllister. Roundup Press, 2008. 200 pp., $39.95.

Photographer Bruce McAllister has put together an impressive collection of images, both archival and contemporary, of bush flying over and onto the pristine mountains, forests, lakes, and streams up north.

Vulcan Test Pilot: My Experiences in the Cockpit of a Cold War Icon

by Tony Blackman. Casemate Publishing, 2007. 218 pp., $39.95.

EXPECT THIS MODEST AUTHOR to provide a yank-and-bank account of heroic V-bomber flying, pounding the Argies in the Falklands, beating up the British countryside low-level with four straight-turbojet Rolls-Royce Olympuses, or looping the big bird at Farnborough and you'll be disappointed. (Although we do get descriptions of some rigorously planned airshow aerobatics.) Accept this book for exactly what the title says and you will have in your hands a fascinating, gracefully written, and superbly knowledgeable flight-test manual describing in detail what it took to turn a futuristic late-1940s bomber design into a squadron-ready nuclear weapon. After all, before the lead designer limned this big manta ray of an airplane, his previous major work was on the barn-door Avro Lancaster.

In common with other delta-wing transonic aircraft of the time, the Avro Vulcan had a classic...well, some would call it a fault, others a "handling characteristic." As the airplane approached Mach 1, more and more up elevator was needed to keep it level. At about Mach .98, the elevator was fully up, and a teensy bit more speed would instantly overwhelm the elevator and tuck the airplane into an ever-increasing dive. Recovery was, let us say, difficult, since back stick had no effect.

This was only one of the Vulcan's quirks, and it's fascinating to read how a team of brave, skilled, no-nonsense Brits flying in pinstripe suits (in at least one photograph included in this book) turned the design into an airplane the size of an Airbus that could maneuver like a Spitfire.

Though outside the scope of Tony Blackman's book, it's instructive to remember that the Vulcan went to war only once, in the Falklands. Three times Iron Lady Thatcher sent Vulcans from Ascension Island to the Falklands to bomb Port Stanley. Three times 13 Vulcans and Handley-Page Victors took off from Ascension and flew far south. One Vulcan was "the bomber," one was a backup, and the other 11 airplanes were tankers. Tankers refueled the mission airplane and refueled each other until finally just one Vulcan was left to attack the target.

In three tries, just one 1,000-pound Vulcan bomb hit the Port Stanley runway.

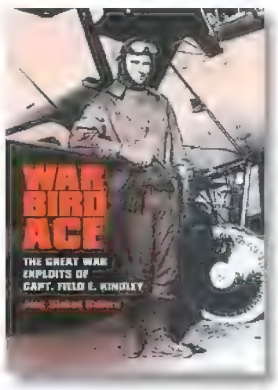
I haven't done the math, but I'm guessing that if Toyota sold Priuses for the next two centuries, they wouldn't save enough gas to replace the 3.3 million gallons that were burned in this wave-the-flag exercise.

STEPHAN WILKINSON IS AN *AIR & SPACE/SMITHSONIAN* CONTRIBUTING EDITOR AND THE AUTHOR OF *THE GOLD-PLATED PORSCHE* (LYONS PRESS, 2005).

War Bird Ace: The Great War Exploits of Capt. Field E. Kindley

by Jack Stokes Ballard. Texas A&M University Press, 2007. 208 pp., $29.95.

AVIATION LITERATURE is amply filled with pilot memoirs and biographies. Most all of the influential and colorful figures have been treated in some fashion, so it is always refreshing to read accounts of lesser-known aviators whose stories have something to contribute to the historical understanding of flying, and the setting and time in which they lived. Such is the case with *War Bird Ace*, Jack Stokes Ballard's account of First World War pilot and ace Captain Field E. Kindley. Kindley, a Kansas youth who entered the U.S. Army shortly after the American declaration of war in 1917, volunteered for the air service, served and fought valiantly in Europe, achieved 12 aerial victories, and was awarded the Distinguished Service Cross and the Distinguished Flying Cross. His story provides all the excitement and daring of many combat pilot accounts, but Ballard's offering also gives some glimpses of World War I flying that are less often highlighted.



Unlike most Americans who trained and fought alongside the French, Kindley was among a small number who were assigned to British units before American-led squadrons were organized and operational. Ballard's discussion of Kindley's flight instruction and orientation to combat flying the "British way" provides a useful comparison to the more-often-chronicled French approach. For example, the British moved students to advanced aircraft more rapidly than the French; the accelerated schedule qualified pilots for combat faster, but also resulted in more training accidents. The discussion of Kindley's experiences as a squadron leader during the immediate post-war occupation of Germany also offers details not typically presented in this genre of aviation writing.

Ballard does not often delve much below the surface of Kindley's personality, and I suspect this is likely because of a lack of source material. Nor does the book stray very far from the day-to-day events of Kindley's life. Nonetheless, *War Bird Ace* is an entertaining and useful account of an aviator whose story is worth knowing.

PETER L. JAKAB IS CURATOR OF EARLY FLIGHT AND WORLD WAR I AVIATION HISTORY AT THE NATIONAL AIR AND SPACE MUSEUM. AN EXPERT ON THE WRIGHT BROTHERS, JAKAB IS THE AUTHOR OF *VISIONS OF A FLYING MACHINE*, WHICH DOCUMENTS THE ENGINEERING METHODS ORVILLE AND WILBUR EMPLOYED TO DEVELOP THE FIRST AIRPLANE.

>>> Stargazing <<<

Starfinder: The Complete Beginner's Guide to Exploring the Night Sky

by Carol Stott. DK Books, 2007. 72 pp., $30. To order the Starfinder from the National Air and Space Museum, call (202) 357-1387.

THE STARFINDER PACKAGE contains a book about celestial objects, flashcards to help memorize 88 constellations, and a red LED flashlight with which you can look at the star chart in the dark without setting your night vision back 10 minutes.

After spending a couple hours reading the book, I fixed the chart to the proper date and time (with the attached sticky pads) and bundled up to rediscover the night sky I'd long neglected.

Alone, cold, and staring up into space from a hilltop park bench, I wanted instant gratification. Of course, the whole thing hinges on being able to find Polaris – so maybe a compass should have been included. Okay, let's line this baby up. Big Dipper, where are you? Little Dipper? Great...they must be behind those trees.

The star chart is a bit wonky. It's embedded in the package's carton and can shift because the sticky pads don't stick all that well. Still, once I'd learned to hold the carton more firmly, I was able to work off Cassiopeia to find boxy Pegasus, the cross of Cygnus the Swan, and bright Vega and its constellation Lyra. Perhaps next time I'll bag that North Star.

SAM GOLDBERG DEVELOPS EXHIBITS FOR SEATTLE'S PACIFIC SCIENCE CENTER.

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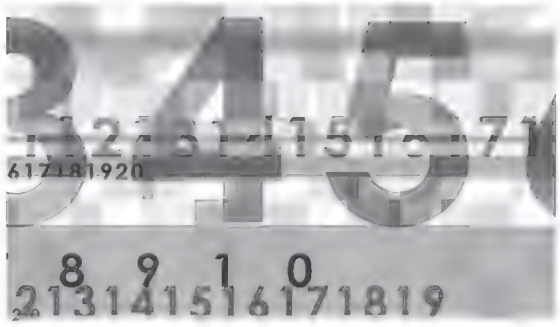

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providing a fun entry into subjects that are often taught in a lackluster way.

Dr. Benjamin assumes you have no more than a distant memory of high school math. He believes that it is his job to fan those embers into a burning interest in the subject he loves so much—and in which he takes such exquisite joy.

About Your Professor

Arthur T. Benjamin is Professor of Mathematics at Harvey Mudd College, where he has taught since 1989. He earned a Ph.D. in Mathematical Sciences from Johns Hopkins University. The Mathematical Association of America honored him with national awards for distinguished teaching in 1999 and 2000 and named him the George Pólya Lecturer for 2006–08.

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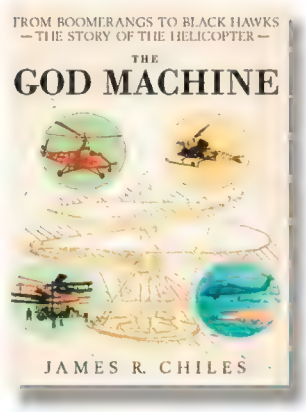
The God Machine: From Boomerangs to Black Hawks – The Story of the Helicopter

by James R. Chiles. Bantam, 2007. 368 pp., $25.

AUTHOR JIM CHILES, an *Air & Space* contributor, doesn't skimp on the helicopter's past, but he doesn't waste many pages on the usual suspects, like inventor Igor Sikorsky, either. And to the disappointment of "M*A*S*H*" fans, he ignores the helicopter's introduction as an air ambulance during the Korean War. However, he does address the importance of rotorcraft in Vietnam, from their introduction in 1961 to the fall of Saigon in 1975.

In the book's most amusing section, Chiles recounts how Lyndon Johnson wore out a Sikorsky in his come-from-behind 1948 Texas senate campaign by reaching 400 small towns ignored by his opponent, Coke Stevenson. Writes Chiles: "Johnson used the [helicopter] to campaign between towns whenever the opportunity arose, landing near construction crews to shake hands or using the helicopter-mounted bullhorn to shout at farmhands from the air: This happened whenever Johnson saw 'more than two people and a big dog,' according to [pilot Jim] Chudars."



Chiles also details the rise of the news helicopter: the sublime (if you can call the O.J. Simpson low-speed Bronco chase "sublime") and the ridiculous (Los Angeles television stations interrupting regular programming to follow a sick dolphin being trucked to an animal hospital). More seriously, the book covers old, bold pilots like Link Luckett and the ice-nerved techniques he employed to fly the first rescue mission off Mount McKinley in a seriously underpowered machine.

Need an explanation of why people love helicopters when they're being pulled from burning buildings yet despise them when the rotorcraft haul the rich to the Hamptons? With Chiles' help, I understand how the Helicopter Noise Coalition shut down the 60th Street Heliport on Manhattan's Upper East Side. I only wish someone could explain why news choppers are allowed to hover at dawn for beauty shots of the Queensboro Bridge. Fly away, Chopper 4, and let me sleep.

PHIL SCOTT IS THE AUTHOR OF *HEMINGWAY'S HURRICANE.*

>>> Out of the Vault <<<

Empire of the Sun

DVD. Rated PG. Warner Home Video, 2001. $14.98.

STEVEN SPIELBERG'S *Empire of the Sun*, released in 1987, never achieved the box office success of the director's many blockbusters, such as *Raiders of the Lost Ark* and *Jurassic Park*, but this lesser-known film is one of his best.

Empire of the Sun is a visually stunning work that tells the story of James "Jamie" Graham, a pre-teen British boy living with his wealthy expat parents in Japan-occupied China during World War II. Jamie, played brilliantly by Christian Bale, loves airplanes, and he is thrilled by the frequent sight of Japanese fighters flying over his family's mansion outside of Shanghai. Before long, Japanese tanks are rolling through the streets of Shanghai, and thousands of British residents are attempting to escape. In the chaos, Jamie is separated from his parents, and he eventually ends up in an internment camp for Brits and captured American airmen.The camp is next to an airfield run by the Japanese.

Though life without his parents is difficult, Jamie's love of aviation sustains him, and he even develops a friendship with a young Japanese pilot-in-training. In a scene that shows just how far the sun has set on Japan's war effort, Jamie watches a ceremony for three kamikaze pilots about to depart on their final mission. With their Zeros parked nearby, each pilot is addressed by the airfield commander and serenaded in song by the other pilots in the squadron. Jamie, separated from the men by a barbed-wire fence, gazes admiringly at them and raises his hand in salute.

Toward the film's end, the airfield comes under daytime attack from U.S. P-51 Mustangs, which carve long, lovely lines in the sky as they strafe and bomb the runway and hangars. While the other internees run for cover, an exuberant Jamie runs to the top of a building to watch the action. Time seems to slow down as one of the pilots, flying a Mustang named *Tugboat*, waves at the boy. "P-51!" yells Jamie. "Cadillac of the sky! Horsepower!" It's an expertly structured scene from Spielberg, suggesting that even in war there is beauty – and joy.

DIANE TEDESCHI IS AN *AIR & SPACE* ASSOCIATE EDITOR.

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Batteries Included

FROM THE MOMENT Explorer 1 reached orbit a half a century ago, its days were numbered. The problem? Primitive, non-rechargeable mercury batteries. The high-powered transmitter aboard America's first satellite quit working after 12 days; the low-powered transmitter lasted for two and a half months. But that was enough for Explorer's Geiger counter to make a key discovery: the Van Allen radiation belts around Earth.

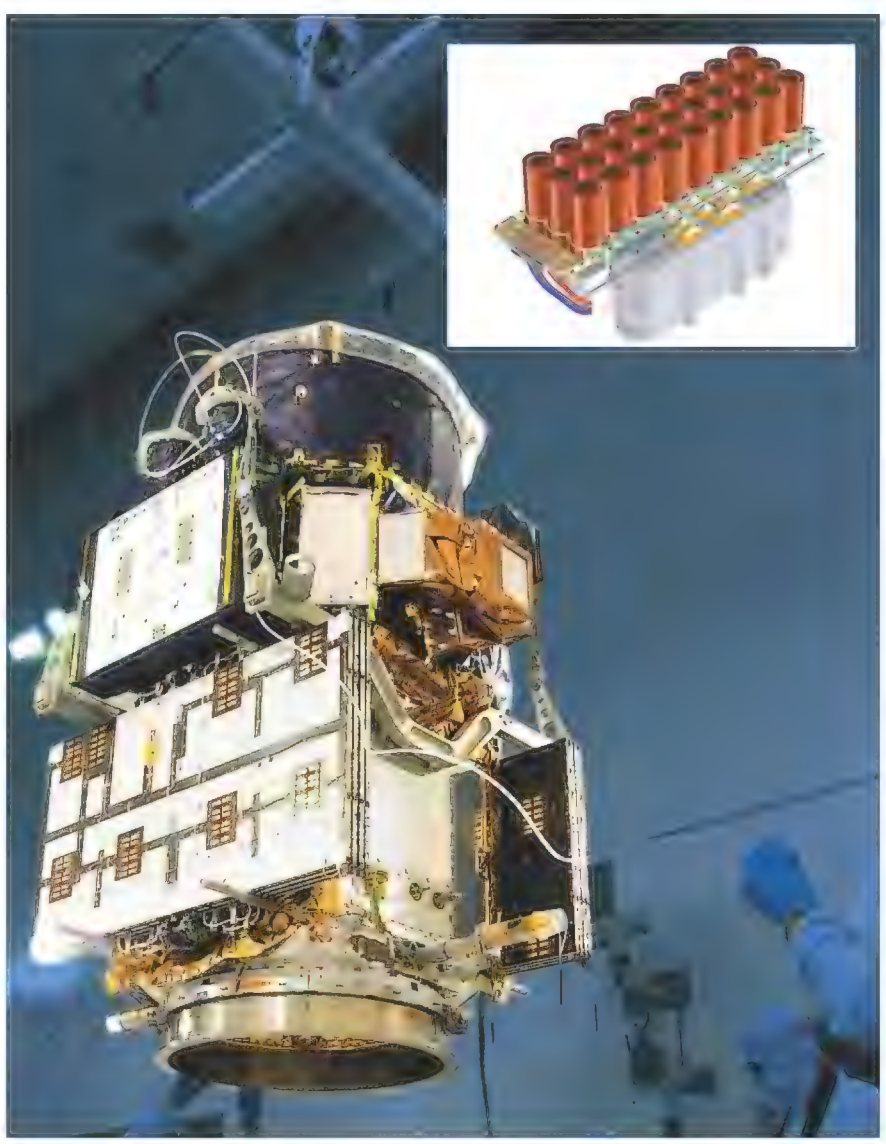
Today, Earth-orbiting science satellites are asked to do much more, so they carry more powerful batteries that can be recharged to produce energy for years. The joint U.S.-French CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation) satellite, for example, launched in April 2006, has rechargeable lithium ion batteries that are expected to power the atmosphere-observing laser rangefinder, infrared imager, and wide-field camera for at least three years.

Early space batteries were not only limited in lifespan, they were also heavy, since they used metals such as nickel, silver, or zinc. At 12 pounds, Explorer's Mallory-brand batteries accounted for 40 percent of the weight of the satellite. Batteries on typical satellites today account for a quarter or less of the weight.

Now, NASA program managers expect to get at least five to seven years from batteries. A satellite in low Earth orbit is in sunlight for an hour of each 90-minute orbit, so during that time its solar arrays power the instruments and recharge the battery. In the remaining half-hour of darkness, the satellite uses the battery.

INSET IMAGES: JPL; MAIN IMAGE: NASA HEADQUARTERS

Batteries for the low- (inset top) and high-power transmitters on Explorer 1 were nearly half the satellite's weight.



INSET: NASA GODDARD; MAIN IMAGE: NASA LANGLEY

CALIPSO's lightweight lithium ion batteries (inset) are recharged by the spacecraft's solar arrays, shown folded.

Nickel-cadmium batteries powered many of the early U.S. satellites, and are still in use today. In the 1980s, NASA began moving to nickel-hydrogen batteries, cutting the weight in half. Lithium ion batteries, which cut the weight even further, were developed in the 1990s for a market that never materialized: electric cars. Today, lithium ion batteries are common not only in spacecraft but also in cell phones and laptops.

"On a typical telecommunications satellite, with nickel-hydrogen, you'd have 400 to 450 pounds of battery and it's the size of a loveseat. With lithium ion, it's one-half to one-third the weight and it's the size of a computer box. You end up saving 12 to 15 percent of the mass just by switching technologies," says Annie Sennet-Cassity, director of space sales at Saft, the French battery maker.

That savings could mean more capability for the spacecraft, or could make possible every space program manager's dream: a cheaper launch.

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Mission Unaccomplished. William Campenni logged 4,000 hours in 11 aircraft types during his 33 years with the Air National Guard.

Homebuilt Radiation Belt. Mark Wolverton's new book, *A Life in Twilight: The Final Years of J. Robert Oppenheimer*, will be published later this year.

School of Hard Rocks. Tom LeCompte is a Cambridge, Massachusetts-based freelance writer and pilot who likes to think he does nothing in the extreme.

A Place in the Sun. Bruce Dorminey is the author of *Distant Wanderers: The Search for Planets Beyond the Solar System*.

Stowaways. Bettina H. Chavanne is a Pentagon reporter for *Aerospace Daily & Defense Report*.

Konnichi Wa, Kibo. As a former NASA astronaut, Dan Barry flew three times on the space shuttle, made two trips to the International Space Station, and performed four spacewalks. He now runs his own company, Denbar Robotics.

My Wingwalker. Writer and pilot Debbie Gary retired from airshow flying last summer at the annual AirVenture fly-in at Oshkosh, Wisconsin.

Ladies and Gentlemen: The Aeroplane! Paul Glenshaw is director of the Discovery of Flight Foundation.

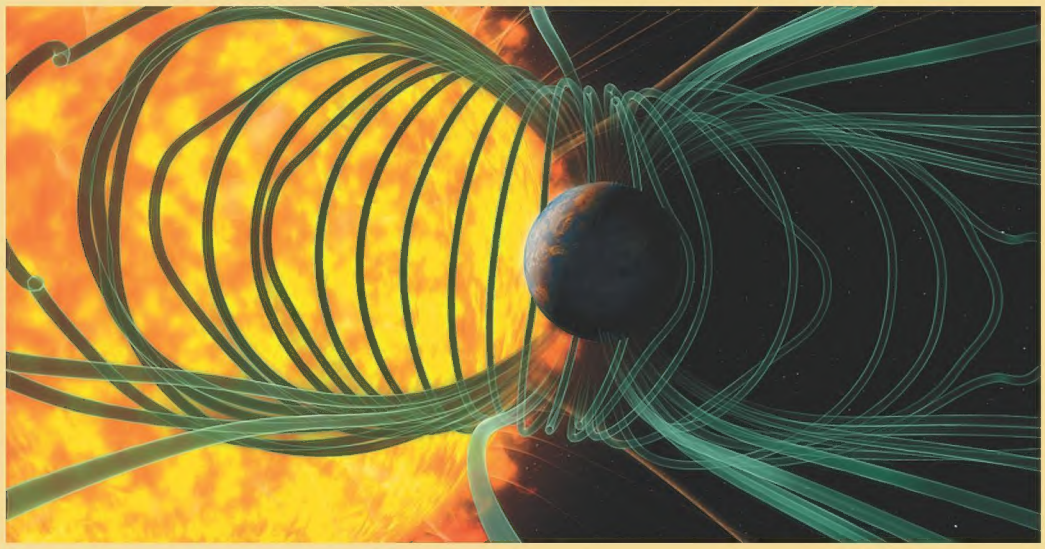
The Misunderstood Professor. Frank H. Winter is a National Air and Space Museum retired curator of rocketry.

The Bone Is Back. David Noland is a writer living in Mountainville, New York.

Batteries Included. Paul Hoversten is executive editor of *Air & Space/Smithsonian*.

Forecast

ON THE WEB AND IN THE WINGS...



NASA

Into the Fury of a Solar Storm

IN OCTOBER 2006, NASA's Solar Extraterrestrial Relations Observatory satellites were launched; now orbiting the sun, they provide scientists with dazzling images of that star in the new IMAX movie *3D Sun* showing at the National Air and Space Museum and sites across the country. See a video trailer at *www.airspacemag.com*.

In a new IMAX movie, viewers can see – in three dramatic dimensions – blasts of solar plasma flying toward Earth, and learn about the flares' possible effects on astronauts, satellites, airplanes, and power grids.

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Plus... Rare footage of World War I pilot training, and a film of Teddy Roosevelt catching a ride with Wright exhibition team pilot Arch Hoxsey at an air meet in St. Louis, Missouri, in 1910 (see "Ladies and Gentlemen: The Aeroplane!," p. 48).

IN THE NEXT ISSUE

E-2 Hawkeye, Eyes of the Fleet
Why the Ugly Betty of naval aviation is the single most important aircraft in the battle.

First to Fly; First to Fall
The raw and risky business of training World War I aviators.

The Pregnant Guppy and Its Offspring
How the gargantuan cargo aircraft got NASA to the moon on time.

CHAD SLATTERY

Sexiest on the flight deck – not.

The Raptor's Edge
Thrust vectoring and the transformation of air combat.

The Phantom at 50

IT IS THE VERY IMAGE OF A COMBAT aircraft—all lines and angles and bulges, with cranked wingtips and a swollen crocodile fuselage topped by a broad trapezoidal fin; later versions were festooned with pods and camera housings that simply added to the clutter. At takeoff, the beast weighed in at more than 60,000 pounds; by contrast, an F-86 Sabre at max takeoff weight barely topped 18,000 pounds.

The last U.S. F-4s were retired in 1996 (a U.S. Air Force RF-4C during the Vietnam War); about 800 still fly worldwide.

The McDonnell F-4 Phantom II began as an idea for a flying radar platform with missiles capable of protecting a carrier battle group, but it evolved into one of the most versatile strike fighters ever built. It made its first flight in May 1958, and it would be built in great numbers: 5,195, according to Boeing, of which 5,057 emerged from the production lines of heritage company McDonnell Aircraft, and 138 under license by the Japanese company Mitsubishi. It still holds the record for production of a supersonic jet aircraft in the United States. (Russia's MiG-21, with more than 10,000 built, holds the all-time world record.)

The Navy, which initially ordered the airplane, knew what it had once the fighter was equipped with a pair of the then-new General Electric J79 afterburning turbojets, and it sent its new Mach 2-capable acquisition off to set a spate of speed and altitude records. The airplane made its first appearance in combat in Vietnam in 1964. The Air Force ordered it as a multi-role fighter and attack aircraft, eventually buying more than the Navy and Marines did, and it got its guns in 1967, when another pod was added to the C model, this one containing a Gatling cannon. Ordnance totaling 16,000 pounds was attached seemingly anywhere it would fit. A B-29, the heaviest U.S. bomber of World War II, carried only 4,000 pounds more.

When it debuted in combat with a mission flown from the deck of the USS *Constellation*, the B model was an all-missile airplane. When the E model first flew in 1967, it had the Gatling cannon built into the airframe, thanks to the lessons learned in combat against more agile, gun-wielding Soviet fighters in Vietnam.

For a time, the F-4 flew as the demonstration fighter for both the Air Force Thunderbirds and the Navy Blue Angels, the only fighter to hold that distinction. When it was replaced by newer and more economical types, airshow crowds missed the noise, the smoke, and the sheer size of the Phantom. To conduct its maneuvers, the big airplane was reputed to use up the boundaries of the county in which the airshow was being held.

When a fighter is sold to all three U.S. air arms, economies of scale come into play and the cost per unit is reduced. In the case of the Phantom, overseas sales expanded the scale even more. Eleven nations acquired either retired U.S. military aircraft or newly built examples, totaling almost 1,200 aircraft. About 800 Phantoms still operate today, flown by Egypt, Germany, Greece, Israel, Japan, South Korea, Spain, and Turkey. Another blessing of volume production is the spare parts pool that results. Surplus aircraft in boneyards get picked clean to keep others of the type flying. Today you can buy components for your F-4 from such firms as Derco Aerospace, Inc., a subsidiary of Sikorsky, as easily as finding a carburetor for your '67 GTO down at the parts store.

Nobody gives trophies to airframes for enduring service, but if they did, the F-4 would be a winner.

GEORGE C. LARSON, MEMBER, NAA

USAF